DETROIT PUBLIC LIBRARY
REG. No. M. 2799
SEP 12 1960
Upper Third

GENERAL INFORMATION

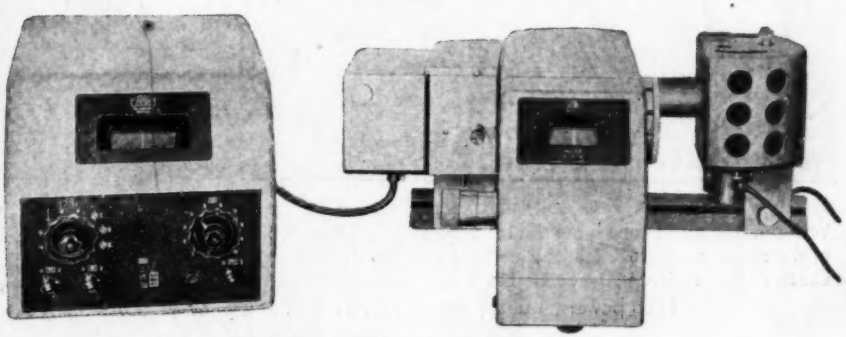
Current Science

Vol. 29, No. 1 JANUARY 1960 Pages 1-40

CARL ZEISS

SPECTROPHOTOMETER

Mains-operated Model PMQ II



Made by Carl Zeiss, Oberkochen, Germany

For precise measurements from 200 mμ in the ultraviolet to 1000 mμ in the near infrared region with high spectral resolution. Write for illustrated literature.

Sole Agents

ADAIR, DUTT & CO. (India) Private LTD.

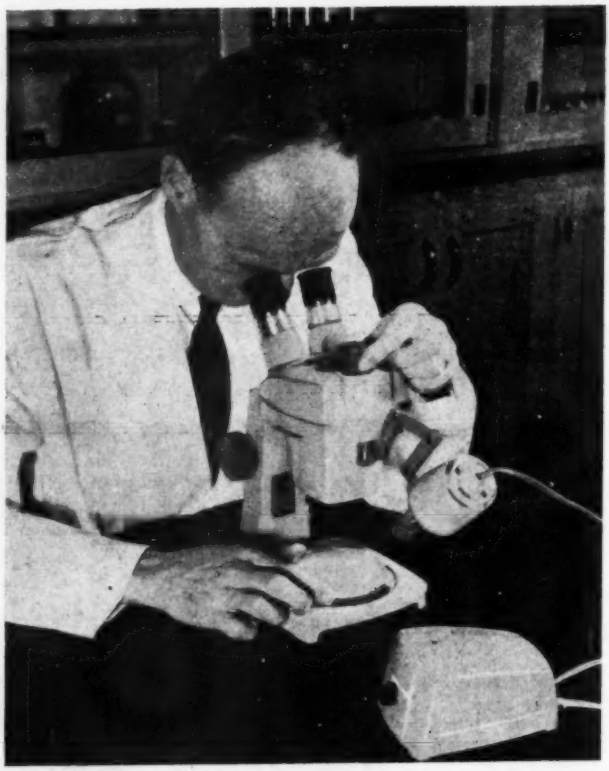
CALCUTTA MADRAS SECUNDERABAD BOMBAY NEW DELHI

TUNE YOUR MICROSCOPE!

Sounds fantastic, but it is a fact with the

BAUSCH & LOMB

NEW 3D STEREOMICROSCOPES



B&L

STEREO

ZOOM

CONTINUOUSLY VARIABLE POWER

THE BEGINNING OF A NEW TRADITION IN MICROSCOPE DESIGN

You turn a knob to tune your radio to the required station, likewise you just turn the knob of the new model B & L Stereomicroscope to get the brilliant stereo image ZOOM to the exact magnification you need. No individual objectives, no nosepiece! Not just a few fixed powers, but any power within the wide stereo range

Made by

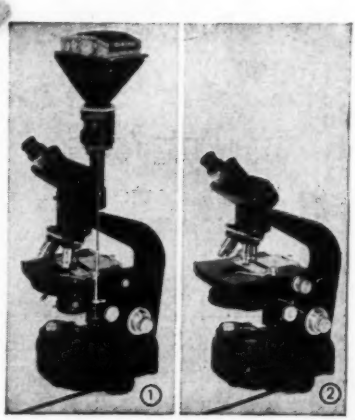
BAUSCH & LOMB OPTICAL CO., U.S.A.

Sole Agents in India

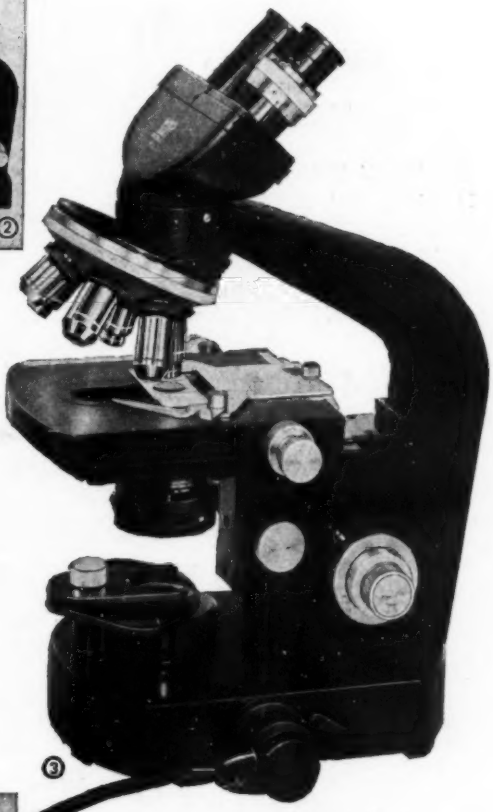
MARTIN & HARRIS (PRIVATE) LTD.

(SCIENTIFIC DEPARTMENT)

SAVOY CHAMBERS, WALLACE STREET, BOMBAY 1



WILD
HEERBRUGG



* The most COMPLETE Microscope so far made

* Ideal for QUALITY PRECISION & VARIETY

WILD M 20

The M 20 Microscope with few of its attachments.

Fig. 1 : With Micro Camera and Binocular Tube;
Fig. 2 : Equipped as Phase Contrast Microscope ;
Fig. 3 : With Six-Hole Nosepiece ; Filter Exchanger, etc. ;
Fig. 4 : Built-in Illuminator for Kohler Illumination.

Sole Agents:

RAJ-DER-KAR & CO.

Sadhana Rayon House
Dr. D. Naoroji Road
BOMBAY-1

Telephone : 26-2304 Telegram : TECHLAB

Branch Office:
44/6 REGAL BUILDING
CONNAUGHT PLACE
NEW DELHI-1

FOR RESEARCH & INDUSTRY

WE MANUFACTURE

GAS PLANTS
AND
BURNERS

FOR USE IN INDUSTRY, LABORATORY, KITCHENS, ALL TYPES OF SCIENTIFIC EQUIPMENTS INCLUDING LEAD CASTLES, EQUIPMENT FOR HANDLING RADIO-ACTIVE ISOTOPES, WATER-BATHS, STILLS, SHAKERS, Etc.

STAINLESS STEEL

FABRICATIONS INCLUDING

TANKS, PRESSURE VESSELS
JACKETED KETTLES, PANS
DISTILLATION STILLS–VACUUM & STEAM
SINKS, STIRRERS, MILK CANS
Etc., Etc.

Enquiries Solicited:

GANSONS (PRIVATE) LIMITED

P.O. BOX 5576 BOMBAY 14

SP/GAN/

EX-STOCK **'PYREX'** BRAND

(MADE IN ENGLAND)

Laboratory Glassware

ALSO

MICROSCOPES—SLIDES—FILTER-PAPERS

(MADE IN CHINA)

available from ready stock

For further details please contact

LABORATORY FURNISHERS

DHUN MANSION, VINCENT ROAD, DADAR, BOMBAY 14

Telephone : 42741

Branch: **AHMEDABAD**

CRAFTSMAN

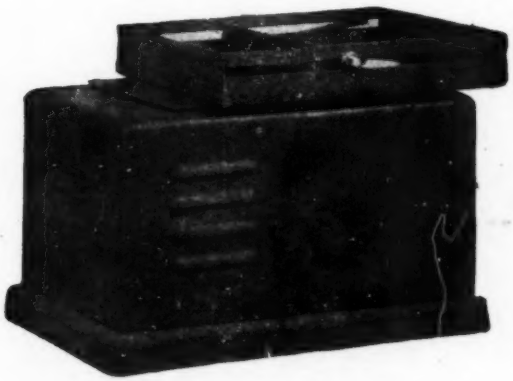
A SYMBOL OF QUALITY & SERVICE

—FOR—

LABORATORY RESEARCH

AND

INDUSTRIAL INSTRUMENTATION



Offer

* A Complete RANGE PHOTOELECTRIC COLORIMETERS
* OVENS, FURNACES, INCUBATORS
* SHAKERS & WATERBATHS
* CONTROLLERS, PYROMETERS & THERMOCOUPLES
* DIAL THERMOMETERS

ASK FOR PRICES AND MORE DETAILS

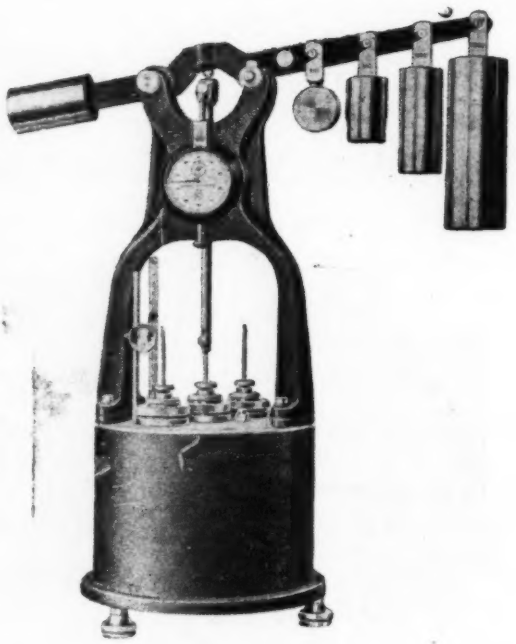
CRAFTSMAN ELECTRONIC CORPN. (PRIVATE) LTD.

SETHNA HALL, NESBIT ROAD, MAZAGAON, BOMBAY 10

Telegram : CRAFTRONIC Phone : 42346

HOPPLER CONSISTOMETER

AN ABSOLUTE CONSISTOMETER



FOR RHEOLOGICAL INVESTIGATIONS

—Viscosity, plasticity, flow points, etc., and for measurements of elasticity and hardness determinations

Manufactured by

VEB PRUFGERATE—WERK, MEDINGEN

DRESDEN—GERMANY

Sole Agents:

GORDHANDAS DESAI PRIVATE LTD.

SIR PHEROZESHAH MEHTA ROAD, BOMBAY 1

Branches at:

P-7, MISSION ROW EXTENSION
CALCUTTA 1

4/2 B, ASAF ALI ROAD
NEW DELHI

22, LINGHI CHETTY STREET
MADRAS 1

cenco

CENCO-MEINZER INDUSTRIAL SIEVE SHAKER

An ideal instrument for mechanical analysis of industrial materials, or for sieving heavy mineral powders, light organic samples or fine pharmaceutical powders, provides for very quick and at the same time accurate separation by a unique shaking motion made possible by its new design. Accommodation capacity for six sieves offers scope of separation into six components in a single operation.

SOLE DISTRIBUTORS

THE SCIENTIFIC INSTRUMENT COMPANY LTD.

ALLAHABAD BOMBAY CALCUTTA MADRAS NEW DELHI

Routine Values

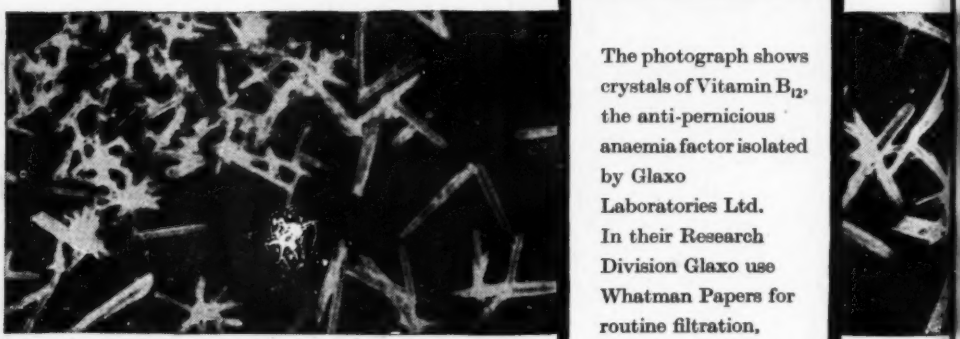
a concept of importance for all research workers

The concept signifies a painstaking empiricism, the thorough regard for routine detail, those less dramatic aspects of research. Concern for "routine values" covers many things, from the design of apparatus to the quality of research materials. It is as relevant in the development of papers for filtration as to work in any other branch of science or technology.

Applied for more than a century, the concept has set a seal of excellence on every Whatman Filter Paper.

The result is that *Whatman* has come to stand for the most reliable range of filter papers. They are an automatic choice of research organisations in Great Britain and in many other countries. They bring a consistently high standard of performance—a routine Whatman feature—to all filtration procedures.

The range of Whatman Filter Papers is discussed in the "Filtration Section" of the Whatman catalogue. Please write for a copy of this monograph and of the Whatman "Buyers' Guide."



The photograph shows crystals of Vitamin B_{12}, the anti-pernicious anaemia factor isolated by Glaxo Laboratories Ltd. In their Research Division Glaxo use Whatman Papers for routine filtration, as well as for chromatography and electrophoresis.

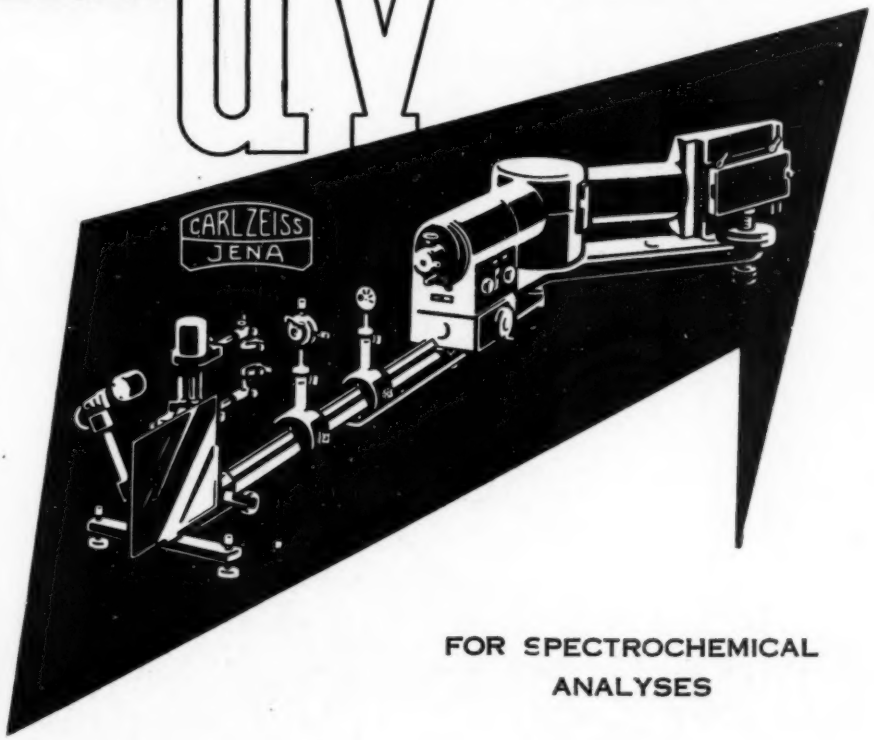
H. REEVE ANGEL & CO LTD
GT. BRITAIN 9 Bridewell Place London EC4

Sole distributors of

WHATMAN FILTER PAPERS

Manufacturers W. & R. Balston Ltd.

ZEISS UV SPECTROGRAPH Q. 24



FOR SPECTROCHEMICAL
ANALYSES

VEB CARL ZEISS JENA

Sole Agents

GORDHANDAS DESAI PRIVATE LTD.

SIR PHEROZESHAH MEHTA ROAD, BOMBAY 1

Branches at:

P-7, MISSION ROW EXTENSION
CALCUTTA 1

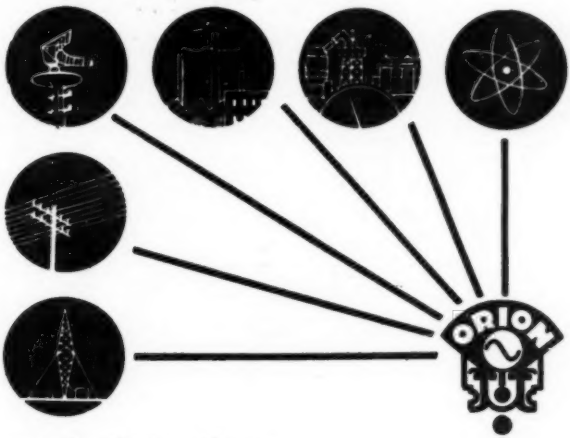
4/2-B, ASAF ALI ROAD
NEW DELHI

22, LINGHI CHETTY STREET
MADRAS 1

RADIO LAMP WORKS LTD.

BOMBAY · CALCUTTA · NEW DELHI · MADRAS · KANPUR · INDORE · WARDHA · GAUHATI

Electronic Measuring Instruments for all Branches of Science and Industry



Measuring Instruments for Nuclear Physics

Elements for Automatic Control

Measuring Instruments for Industrial and Scientific Applications

Microwave Measuring Instruments

Telephone and Telecommunication Measuring Instruments

Radio-Technical Measuring Instruments

EXPORTERS:

METRIMPEX

HUNGARIAN TRADING COMPANY FOR INSTRUMENTS

Letters: Budapest 62, P.O.B. 202 (Hungary)

Agents for all India dealing in:

Radio Telephony Instruments and Microwave Engineering Instruments
Eastern Electronics, Eletcrical and Communication Engineers
FARIDABAD (Gurgaon District)

Agents dealing in:

Nuclear and Industrial Instruments for the territories of West Bengal, Orissa, Assam, Bihar, Punjab, Uttar Pradesh, Madhya Pradesh
Advani Private Ltd., 3 D, Garstin Place, CALCUTTA-1

For the rest of India dealing in

Nuclear and Industrial Instruments: Eastern Electronics, FARIDABAD

THE SUMMIT SURGICALS

27/29, POPATWADI, KALBADEVI ROAD

BOMBAY 2

Grams: "SURGESUMIT"

Furnishers of

LABORATORY APPARATUS
SCIENTIFIC INSTRUMENTS
SURGICAL AND HOSPITAL REQUISITES

Price List on Request

SP/SS/1 al

LET US HELP YOU

in obtaining

ALL LABORATORY EQUIPMENTS

—We specialise in—

SCIENTIFIC { INSTRUMENTS / APPARATUS / APPLIANCES

AND

LABORATORY CHEMICALS

INDSALES CORPN.

11, HORNIMAN CIRCLE

BOMBAY-1

Call: 252762 **Gram: "ANALYTICAL"**

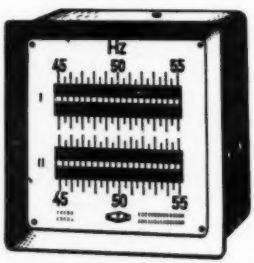
TEMPO LABORATORY EQUIPMENT

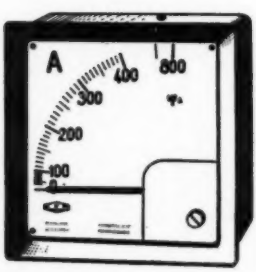
ELECTRIC OVEN

TEMPO INDUSTRIAL CORPORATION (PRIVATE) LTD.

Sonary Road, Paranjpe 'B' Scheme, BOMBAY-57

Electric Measuring Instruments





UNIVERSAL MEASURING INSTRUMENTS

PRECISION MEASURING INSTRUMENTS

INSULATION TESTERS

MEASURING INSTRUMENTS FOR SWITCH-BOARDS

PORTABLE MEASURING INSTRUMENTS

BRIDGES AND DECADE RESISTANCES

EXPORTERS :

Metrimpex Hungarian Trading Company for Instruments

Letters: BUDAPEST 62, P.O.B. 202
HUNGARY

Cables: INSTRUMENT BUDAPEST

REPRESENTATIVES :

Essential Engineering Company

11, Botawala Building
Horniman Circle

BOMBAY - 1

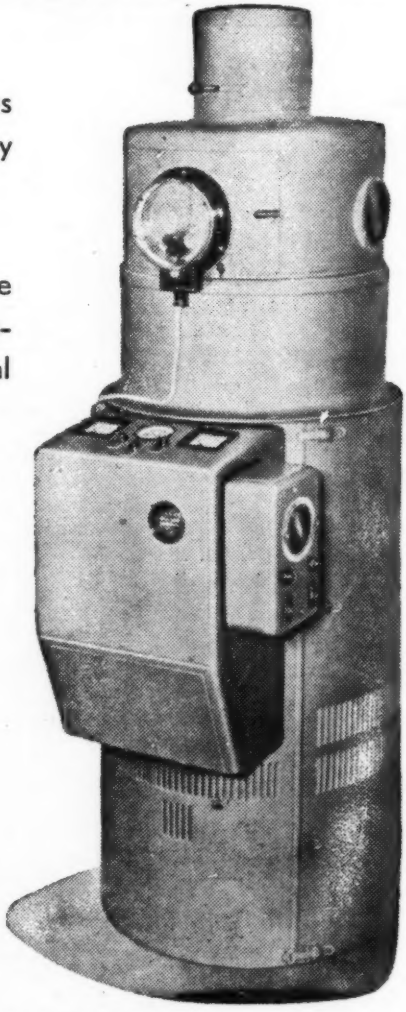
FADING AND WEATHER TESTING APPARATUS

XENOTEST-W

For Textiles, Paints, Dyes, Artificial Leather, Paper, etc.

The Fade Testing apparatus with temperature and humidity control and weathering device.

Testing accelerated to the maximum with exact reproduction of sunlight and natural weather conditions.



Ex: M/s. Quarzlampen G.m.b.H., Germany

For particulars write to Sole Agents:

TOSHNIWAL BROS. PRIVATE LTD.

198, JAMSHEDJI TATA ROAD, FORT, BOMBAY 1

BRANCHES:

KACHERI ROAD, AJMER
172, DHARAMTALLA ST., CALCUTTA 13
14-B/4, N.E.A., UTTARI MARG, NEW DELHI 5
9, BLACKERS ROAD, MADRAS 2

Current Science

Vol. XXIX] JANUARY 1960 [No. 1

CONTENTS

	Page
On the Sensations of Colour and the Nature of the Visual Mechanism—Sir C. V. Raman	1
The Indian Academy of Sciences	7
Centenary of Spectral Analysis	8
Ground State of the C_2 Molecule	9
Industrial Hygiene—Bhola D. Panth	10

Letters to the Editor

A Note on the Orthogonal Polynomials —A. K. Rajagopal 13

Potential Constants of $VOCl_3$—P. Babu Rao and K. Sreerama Murty .. 14

Thermal Expansion of Cæsium Iodide by X-Ray Diffraction and the Grüneissen's Parameters—P. D. Pathak and N. V. Pandya 14

Hydrated Compounds of Uranium from Uranium (IV) Oxycarbonate—Balaram Sahoo and D. Patnaik 16

Remarks on Pinguite—A. Bhaskara Rao 16

Quartz Veins in the Yellandlapad Rocks —Y. Janardan Rao 17

Studies on Equilibrium Relative Humidity (E.R.H.) for Onion Powder—J. S. Pruthi and Girdhari Lal 19

On Two Palm Fruits from the Deccan Intertrappean Beds of Mohgaon Kalan —U. Prakash 20

A Method for a Permanent Record of Chromatogram—S. Idelman and B. Seshadri 21

Investigation of Amino-Acids in the Berries of Withania somnifera *Dunal*— C. K. Atal and A. E. Schwarting .. 22

A Note on the Ovule Development in Carpelloid Stamens of a Nicotiana *Hybrid*—K. V. Krishnamurty and K. Appa Rao 23

Abnormal Occurrence of a Yellow Fledgling in the Desert Locust—D. R. Bhatia and Kartar Singh 24

On the Occurrence of an Adult Amphistome in Sheep Lung—S. M. Sood .. 24

4-Winged Fruit of Terminalia crenulata *Roth*—V. G. Phatak and G. M. Oza .. 25

Occurrence of Rauwolfia canescens *Linn. in Ganjam District*—G. V. Subba Rao 25

Smut on Onion and Garlic in Mysore— N. S. Venkatakrishniah 26

Accessory Chromosomes in Pennisetum typhoides—J. V. Pantulu 28

A New Species of Oocystis (O. kumaonensis *Sp. Nov.*) *from Naini Tal*—K. P. Singh 29

Some Observations on Vegetative Propagation of Ziziphus mauritiana, *Lam.* (Ber) *from Gootees and Cuttings with the Aid of Growth Regulators*—O. S. Jauhari 30

Occurrence of Heterosporium *Blight of Onions in India*—T. N. Kaul 31

Studies in the Genus Cryptostegia—*Preliminary Observations of the Corolline Corona*—A. R. Chavan, S. D. Sabnis and C. H. Pathak 32

Reviews 33

Science Notes and News 37

SPECTROSCOPIC EQUIPMENT
AND
ACCESSORIES
FOR
QUANTITATIVE ANALYSIS & RESEARCH WORK

Light sources like Arc Lamps with universal movements, precision slits, mountings for spectrographs, cameras, microphotometers, etc., etc.

Entirely Our Manufacture

For full particulars, please write to :

THE GENERAL ENGINEERING AND SCIENTIFIC CO.
WALTAIR, VISAKHAPATNAM-3
(S. INDIA)
GRAMS : " ELECTRONIC "
Technical Adviser:
Dr. I. RAMAKRISHNA RAO
M.A., Ph.D. (Cal.), D.Sc. (Lond.)

'STANDARD' RHEOSTATS'

SINGLE, DOUBLE & FOUR-TUBE

COVER A WIDE RANGE
FOR USE IN
LABORATORIES & WORKSHOPS

Made by:

THE STANDARD SCIENTIFIC INSTRUMENTS CO.
115, BRODIES ROAD, MADRAS 28

For
ZOOLOGICAL SPECIMENS
REQUIRED BY
LABORATORIES
AND
INSTITUTIONS

Consult:

Bombay Biological House
Dealers in Zoological Specimens
119, Hindu Colony, Dadar, Bombay 14

Established 1941
Phone : 61813 Gram : PHERETIMA

BOROSIL
LABORATORY GLASSWARE

such as

FLASKS, BEAKERS, CONDENSERS, MEASURING FLASKS, MEASURING CYLINDERS, PIPETTES & ANY SPECIAL APPARATUS MADE TO DESIGN

and

PENICILLIN VIALS, VACCINE BULBS— WHITE & AMBER

ALL OTHER APPARATUS & EQUIPMENT MANUFACTURED TO CLIENT'S DESIGN

INDUSTRIAL & ENGINEERING APPARATUS CO. (PRIVATE) LTD.
CHOTANI ESTATES, PROCTOR ROAD
GRANT ROAD, BOMBAY 7

ON THE SENSATIONS OF COLOUR AND THE NATURE OF THE VISUAL MECHANISM*

SIR C. V. RAMAN

1. INTRODUCTION

LIGHT and colour play a fundamental role in human life and activity. We are therefore naturally led to ask various questions concerning them and the sensations which they evoke. How do our eyes perceive light? Why is it possible for our eyes to discriminate between different kinds of light, thereby enabling us to label them with distinctive names? It is proposed in this address to consider these and related questions and endeavour to answer them.

We may usefully remind ourselves at the outset that the physical phenomena exhibited by light may be divided into two classes. The first class includes various optical effects such as reflection, refraction, interference and diffraction. In all these effects, we are concerned with the propagation of light considered as wave-motion in space. In the other class of phenomena which includes the emission and absorption of light, fluorescence and the photoelectric effect, we are concerned with energy transfers and energy transformations. Such phenomena find a satisfactory explanation only when we consider light to consist of discrete units or quanta of energy. Accordingly, they fall within the scope of the quantum theory of radiation.

The dual role played by radiation is also evident in the functioning of our visual organs. The formation of well-defined images on the retina of our eyes is clearly a phenomenon falling within the range of wave-optics. But it is clear that the visual mechanism by which we perceive light and colour lies outside the scope of wave-optics and should be considered and investigated from the standpoint of the quantum theory. This is the point of view adopted and developed in the present address.

We shall begin with a brief survey of the facts of the subject.

2. THE PERCEPTION OF LIGHT AND COLOUR

The sensations excited by light are of two distinct kinds, luminosity and hue or colour. Though they are essentially subjective in nature, they can be brought within the scope of physical definition and measurement by inter-comparison and equalisation of the luminosity or colour of two adjacent illuminated areas. This is indeed the procedure on which visual photometry and colorimetry depend. The human eye can function over an enormous range of intensities. But at the lowest levels of illumination, *e.g.*, in night-vision, the eye can perceive only differences of luminosity but is unable to appreciate colour. At such levels also, it is insensitive to the light which is normally perceived as red in hue. For the proper appreciation of colour, it is necessary to work at levels of illumination which are fairly high and which have to be employed so that, in other respects as well, our eyes can function efficiently. Colour and colour differences are also best observed and studied in direct vision, in other words when the eyes are turned to view the objects under observation and their images are formed at or near the fovea centralis on the retina. Colour can be perceived also in averted vision up to fairly large angles, but it does not then lend itself to any precise comparison and measurement.

Two kinds of light are of special importance. One of them is white light, in other words light exhibiting no perceptible colour. The other kind of light is that which appears at various points in a well-resolved spectrum. The colours ordinarily met with may be described as a mixture of white light with some particular spectral colour, the result of such mixture exhibiting the same hue as the pure spectral colour but in an unsaturated or diluted form. This way of describing and classifying colours may be made completely comprehensive, if besides the pure spectral colours, we also consider the colours which are not observed in the spectrum but which may be obtained by superposing light from the two ends of the visible spectrum, *viz.*, red and violet, in various proportions. Taking the pure purples arising in this fashion together with the pure colours of the spectrum, we may say that all colours that come within the scope of colorimetry may be described as mixtures arising from the addition therewith of appropriate quantities of white light. It follows from what has been stated that our chief concern is with the subject of monochromatic colour vision. The results of colour mixture are a matter of secondary importance.

* Presidential Address to the Indian Academy of Sciences delivered on the 26th December 1959 at the Annamalai University in Chidambaram.

Conventionally, the colours of the spectrum are described as six in number. Actually, the normal human eye can discern in the spectrum not less than 150 distinct patches of colour which cannot be made to match one another in colour merely by adjusting their intensities. Except at the two extreme ends of the visible spectrum, a change of 50 angstroms in wave-length is more than sufficient to result in an observable difference in colour. Indeed, a much smaller difference suffices over a large part of the visible spectrum. The change in wavelength needed for an observable change of colour has been determined over the whole range of the visible spectrum by several investigators and the hue-discrimination curve thus drawn shows some remarkable features. At four points in the spectrum, at the wave-lengths (in angstrom units) 4400, 4900, 5900 and 6300, it dips down and the change in wave-length required for a perceptible change of colour reaches low values. The wave-lengths 4900 and 5900 are specially conspicuous in this respect, a change of 10 angstroms in wave-length sufficing to produce an observable change of colour, while at intermediate wave-lengths it is larger, rising to 20 angstroms at 5400 angstroms. The dips in the curve at 4400 and 6300 are less conspicuous, the minimum change of wave-length needed in their neighbourhood being about 20 angstroms, while at the intermediate wave-lengths 4600 and 6200, it rises to 30 or 40 angstroms.

3. The Physical Basis of Colour

The facts of observation set forth above lead us to ask ourselves the question, what is the physical basis of colour? In other words, what is it that enables the eye to distinguish between various kinds of monochromatic light? The answer to this question has clearly to be sought for in the known physical properties of light itself. The physical characters which distinguish one beam of monochromatic light from another are firstly, the quantity of energy traversing unit cross-section of the beam per unit of time and secondly, the magnitude of the individual energy-quanta. The subjective characters, which enable one such beam to be distinguished from another, are the luminosity of a white surface on which the beam falls and the colour which the surface then exhibits. It is a natural inference that the physical and subjective attributes of the light are related to each other in a fundamental way, *viz.*, total energy flow with luminosity, and the magnitude of the individual quanta with colour. Indeed, if it were not so, photometry and colorimetry would be meaningless exercises of human ingenuity.

We are thus led to conclude that our powe to distinguish between different monochromati radiations by the colour sensations which the excite is a consequence of the fact that ligh consists of distinct units or quanta of energ and that these units are of different magnitude increasing continuously from one end of th spectrum to the other. It follows from thi again that the nature of the visual mechanism is such that it enables these differences to b perceived. We may also infer that the varia tion in the power of the eye to detect change of colour in various regions of the spectrum i a consequence of the special features of th visual mechanism.

4. The Nature of the Visual Process

A difference of ten angstroms in the wave-length of monochromatic light represents a change of only two parts per thousand in the magnitude of the individual light-quanta o which it is composed. We may well ask ourselves, what is the nature of the visual proces or mechanism which makes it possible for ou eyes to appreciate or detect such a very smal change?

The anatomy of the retina makes it clea that its function is to receive the incident ligh energy and to transform it into impulses (presumably of an electrical nature) which trave along the optic nerve to the cerebral centres If the distinguishing character of the light, *viz.* the magnitude of the energy quanta of which i consists, is to reach the cerebral centres, it is clearly necessary that the energy of the quantum incident on the retina is in the first instance completely absorbed and is then transferred completely and immediately to the nervous system. Any additions to or subtractions from the energy would result in an alteration in the characters of the excitation and therefore also of the resulting sensation. The latter, in such circumstances, may indeed be the perception of light but it would lack the specificity indicated as necessary by the facts of colour perception. For the reasons stated, we may exclude from consideration visual mechanisms which assume photochemical changes to occur involving absorption of energy by the retina, and confine ourselves to the simplest possible process, *viz.* the quanta of light energy falling on the retina are absorbed and the energy absorbed is immediately transferred to the nervous system, the absorbing centres then returning to their original state. The fact that the normal human eye can perceive colour throughout the visible spectrum without a gap indicates that it

dequately covered by the absorption spectra of igments present in the retina, the molecules which can function in the manner indicated. The level of illumination at which the colour ense is at its best is fairly high, in other words here is plenty of light which could enable the rocess contemplated to operate. Hence, even only a fraction of the number of energy-uanta incident on the retina are absorbed and en passed on to the nervous system, the esulting effect would be of adequate magni-ude. Moreover, as we have seen, the pigments hich act as absorbers of light return imme-iately to their normal states and can therefore unction repeatedly. In other words, they are ot expendable. It is evident that in these ircumstances, small quantities of the absorbers ould suffice, so small that their presence in he retina need not be very conspicuous. For heir functioning, it is clearly necessary that the bsorbing substances are diffused through the aterial of the retina. Hence, they should be ither themselves proteins or else substances of iological origin which can co-exist with the roteins and other substances present in the etina.

5. The Retinal Pigments

Amongst the products of biological activity at exhibit absorption spectra in the visible egion of the spectrum, the carotenoids and the lood pigments are of special importance. The arotenoids are so named, as they are deri-atives of the hydrocarbon carotene, the chemi-al formula of which is $C_{40}H_{56}$ and which has everal isomers, the most important being -carotene and β-carotene. The carotenoid igment with which we are specially concerned re is dihydroxy-α-carotene whose chemical rmula is $C_{40}H_{56}O_2$. Together with the isomeric ihydroxy-β-carotene (zeaxanthin), it forms the rincipal constituent of the yellow pigment resent in the yolk of the domestic hen's egg. has also been identified as being responsible r the yellow colour of the region in the retina ng known as the macula lutea and has been ppropriately named as lutein, though the alter-ative name of xanthophyll is also to be found ed in chemical literature.

It is of interest to note that the presence in e foveal region of the retina of a pigment hich strongly absorbs blue light can be demon-rated in a simple manner. A cloudless sky viewed for a few minutes through a filter of ep blue glass which transmits only the wave-ngths of the spectrum smaller than 5000 gstroms. If the filter is then suddenly re-moved and the sky viewed directly, an image of the fovea which can be recognized as such by its angular dimensions is seen clearly pro-jected against the sky. The image, however, soon fades away.

Viewed in the ophthalmoscope, the retina appears of a rich red hue, which masks the colouration of the macula lutea. The latter can only be distinguished by using red-free light when it appears as an elliptic spot with the major axis horizontal. The red colour of the retina has itself been attributed to the selective diffusion by the choroid of the light which has penetrated the epithelial pigment of the retina, in other words of light which has passed twice through the latter before it can re-emerge and be observed. Quite apart from the question of the sufficiency or correctness of this explanation, it has to be remarked that the retina is richly supplied by blood vessels which enter into the nervous layer and pass forwards through it, and from their branches give off a minute capillary plexus. The macula receives two small branches and also small twigs directly from the central artery. Though these latter do not reach the fovea centralis and the latter has therefore no blood vessels, the anatomical drawings indicate that the entire blood-supply system of the retina has been so contrived that its central region where vision is most perfect is completely surrounded by blood-rich material from which it could receive the blood-pigments necessary for its functioning. That the blood-pigments are powerful absorbers of light is indicated by the fact that blood is opaque to light and that oxyhæmoglobin can be spectroscopically detected in aqueous solutions as dilute as one part in a hundred thousand. As has already been remarked, no great quantity of a light-absorbing material is needed to enable it to function in the visual mechanism. In these circumstances, we are entirely justified in assuming that blood-pigments are present in the retina in sufficient quantity to function in the manner already explained and that they play a highly important role in the visual process.

6. The Absorption Spectra of the Retinal Pigments

Lutein.—The absorption spectrum of lutein (xanthophyll) can be readily studied with the material obtained from the yolk of an egg. The pigment is completely transparent to all wave-lengths in the red, orange, yellow and green regions of the spectrum. Its absorption is

limited to the blue region in which three bands can be seen, of which the maxima are located at 4800, 4475 and 4200 angstroms, the first two being much more conspicuous than the third. The drop from complete transparency at 5200 to almost complete opacity at 4800 is rather abrupt; the steepest part of the spectrophotometer curve exhibiting this transition appears in the wave-length region around 4900 angstroms. The absorption by lutein diminishes notably as we approach the violet end of the spectrum.

Oxyhæmoglobin.—The scarlet or oxygenated form of blood-pigment exhibits two clearly marked absorption bands, one in the yellow region of the spectrum centred at 5775 and the other in the green at 5385, the first of them being much sharper than the second. A graph exhibiting the transmission of light through an aqueous solution of oxyhæmoglobin shows a deep trough lying in the region of wave-lengths between 5000 and 6000 angstroms, the two absorption bands mentioned above appearing at the bottom of the trough. The percentage of light transmitted rises very steeply on the side of longer wave-lengths, the steepest part of the rise appearing in the region of wave-lengths around 5900. At wave-lengths greater than 6000 angstroms, the absorption is small, though remaining perceptible up to about 6800 angstroms. On the other hand, the transmission which is a maximum around 5000 angstroms diminishes again at still smaller wave-lengths and indeed there is very little transmission below 4400 angstroms. However, by using very dilute solutions or very small absorption depths, the study of the transmission of light at the violet end of the spectrum reveals the presence of a powerful absorption maximum centred at 4145 angstroms, known as the Soret band.

Ferrohæmoglobin.—The two absorption bands of oxyhæmoglobin at 5775 and 5385 are replaced in the case of its reduced form by a single diffuse band centred at 5575 which covers the entire region between them and also extends beyond them, though not very distinctly. In other respects, the spectroscopic behaviour of the two substances is nearly the same. The Soret band of hæmoglobin has its maximum at 4250.

Ferrihæmoglobin.—This pigment exhibits a marked absorption of light over the whole of the visible spectrum including the red end, in this respect differing markedly from the two other blood-pigments. At wave-lengths greater than 6300, however, the absorption diminishes rapidly and becomes weak at the extreme red of the spectrum. Absorption maxima may be recognized which are centred at 6300, 5765, 5365 and 4995, the last-mentioned being very broad and diffuse. The maximum of its Soret band is located at 4060.

We may summarise the foregoing as follows:

A. Lutein is an efficient absorber of light in the region between 4900 and 4400 angstroms. It is wholly ineffective at wave-lengths greater than 5000 but can absorb (though only feebly) wave-lengths at and near the violet end of the spectrum.

B. Ferrohæmoglobin and its oxygenated form exercise a powerful absorption of light in the wave-length range between 5000 and 6000 angstroms, with a resultant maximum centred at 5580 angstroms.

C. Ferrihæmoglobin has an absorption extending over the entire visible spectrum and differs from the other two blood-pigments in possessing a well-defined absorption band at 6300 angstroms.

No reference has been made above to the retinal pigment known as visual purple, since we are concerned here with the colour sensations experienced at normal illumination levels in which, as is well known, visual purple plays no role.

7. The Luminous Efficiency Curve

A remarkable feature of the perception of monochromatic light by the eye is the manner in which its luminous efficiency varies with wave-length over the range of the visible spectrum. A highly pronounced maximum appears at a certain wave-length in the green region of the spectrum and on either side of it the luminous efficiency falls off steeply. The wave-length of maximum efficiency observed with different individuals is found to vary from 5490 to 5700 angstroms, the average being 5576.

The most reasonable explanation of the fact stated above is that it is a consequence of the variation with wave-length of the strength of absorption of light by a pigment present in the retina which receives the energy of the light quantum and passes it on to the nervous system. In the preceding section, it has been remarked that ferrohæmoglobin has an absorption band of which the centre is located at 5575 angstroms. This agrees with the observed average for the wave-length of maximum luminous efficiency of the normal human eye. If its oxygenated form were the operative pigment, it would show two maxima at 5775 and 5385 respectively with a dip midway between them. But since the reduced form would also be present and it

absorption band covers the region between the two bands of oxyhæmoglobin, the resultant would be a maximum at nearly the same position, viz., 5580. The agreement which thus emerges between the location of the absorption maximum of the blood-pigments and of the maximum luminous efficiency in the spectrum is scarcely a matter for surprise in view of the immensely important role that blood and its constituents play in the maintenance of life.

The observed form of the luminous efficiency curve indicates that two other pigments should be present in the retina which are effective absorbers respectively for wave-lengths less than 5000 angstroms and greater than 6000 angstroms, in other words in the blue and the red regions of the spectrum. The former is evidently lutein and there is good reason for identifying the latter with the blood-pigment methæmoglobin, more appropriately designated above as ferrihæmoglobin to indicate its chemical relationship with ferrohæmoglobin, the ordinary form of hæmoglobin. Since the red cells in blood are provided with mechanisms both for the formation of ferrihæmoglobin by the oxidation of ferrohæmoglobin and for its reduction back to the ferrous state, there are good grounds for assuming the presence of ferrihæmoglobin in the retina where it is needed and has a specific role to perform.

8. Hue Discrimination in the Spectrum

The major features of the distribution of luminosity and colour in the spectrum can be ascertained in a very simple manner merely by viewing the white-hot straight filament of a tungsten lamp through a diffraction grating. It then becomes evident that the most luminous part of the spectrum is in the greenish-yellow region and that on either side of it the luminosity falls off unsymmetrically, in other words, more slowly on the side of longer wave-lengths. The observable colour alters with change of wave-length but such change is most rapid at certain points in the spectrum, and relatively slow in the intermediate regions. In particular the change-over from blue to green and from yellow to orange is particularly rapid, while the change from green to yellow is quite gradual. The change from violet to blue occurs in a narrow region of the spectrum, and there are also indications that the change from orange to red is rather abrupt.

The facts stated above find quantitative expression in the hue discrimination curve which has been studied by several investigators. They receive a satisfactory explanation on the basis of the data regarding the retinal pigments and their spectroscopic behaviour. It was remarked earlier that lutein changes over from complete transparency to nearly complete opacity abruptly in the region of wave-lengths around 4900 angstroms. This, it may be remarked, is precisely the place where the hue discrimination curve dips down very steeply. Then again, ferrchæmoglobin changes over from almost complete transparency to nearly complete opacity in the region of wave-lengths around 5900 angstroms. This again is the wave-length at which the hue discrimination curve dips down to its lowest point. In other words, the change from blue to green is rather abrupt for the reason that lutein functions very efficiently at wave-lengths less than 4900 but ceases to function at greater wave-lengths, its place being taken over by ferrohæmoglobin. Similarly the change from yellow to orange is abrupt for the reason that ferrohæmoglobin functions efficiently at wave-lengths below 5900 angstroms but ceases to do so at greater wave-lengths and its place is taken by ferrihæmoglobin. On the other hand, the transition from green to yellow is quite smooth for the reason that ferrohæmoglobin functions over the whole range under consideration. The minor features in the hue discrimination curve noticed in the blue and red regions can likewise be explained in terms of the striking changes with wave-length in the form of the absorption curves of lutein and ferrihæmoglobin which are the pigments functioning in those regions.

9. The Results of Colour Mixture

As stated earlier, the sensation produced by non-homogeneous light may be equated to that resulting from an admixture of white light with an appropriately chosen "pure colour", the latter term including the pure colours of the spectrum as well as the pure purples produced by the superposition of light from the extreme red and violet ends of the spectrum. This fact emerges from the numerous investigations on colorimetry made in the past, the results of which are embodied in the so-called chromaticity diagrams of which there are various forms. We shall here refer to and briefly describe the XYZ type of representation which at the present time is most generally accepted and used.

The XYZ chromaticity diagram takes the form of a closed figure which is roughly triangular in shape with a rounded vertex and a straight base which represents the line of pure purples. The rest of the perimeter of the figure

represents the pure spectral colours arranged on it in a manner which will presently be stated. All observable colours (including white light) are represented by points lying within the closed figure, the point representing white light appearing somewhere near its centre. The pure spectral colours ranging from the extreme red end of the spectrum up to and including a part of the green up to 5350 angstroms appear on one side of the triangle arranged on what is practically a straight line. The pure spectral colours from 5350 to 5050 angstroms appear as the rounded-off vertex of the triangle. The third side of the triangle is a curved arc on which the spectral colours from 5050 angstroms up to the extreme violet end appear. The wave-lengths are however distributed on this arc very non-uniformly. Practically the whole of its length is taken up by the wave-lengths from 5050 to 4600 angstroms, while the rest of the spectrum from 4600 to 3800 (the extreme violet end) is compressed into a very short arc which forms the tip of the perimeter where it joins the line of purples.

The form of the chromaticity diagram as described above has a striking and indeed obvious relationship to the spectroscopic behaviour of the retinal pigments described earlier. The curved arc running from 5050 to the violet end of the spectrum is the region of wave-lengths where lutein exercises a marked absorption, and it is therefore not surprising to find that practically the whole of the arc is taken up by the wave-lengths at which such absorption is greatest. *Per contra*, lutein is completely transparent to all the wave-lengths which appear on the straight line forming the other side of the triangle. This region is covered by the absorption spectra of the blood-pigments where such absorption is strongest, while the rounded-off vertex of the triangle represents the part of the spectrum in which the strength of their absorption falls off rapidly, as is shown by the absorption-curves themselves and is independently confirmed by the rapid drop in the luminous efficiency of the spectrum between 5350 and 5050 angstroms. The form of the chromaticity diagram thus indicates that the three receptors contemplated in the trichromatic theory of vision may be identified respectively with the three retinal pigments lutein, ferro-hæmoglobin (including its oxygenated form) and ferrihæmoglobin operating in their respective regions of absorption in the spectrum.

10. Anomalies in Colour Vision

The blood-pigment ferrohæmoglobin is readily oxidisable to ferrihæmoglobin, but such oxidation is ordinarily inhibited by the circumstance that it can form the molecular compound with oxygen known as oxyhæmoglobin which circulates through the body in arterial blood and is returned after de-oxygenation through the veins. Normally, therefore, ferrihæmoglobin is not present in human blood in any appreciable quantity, though in certain pathological conditions it is known to form a substantial proportion of the blood-pigment. The presence of ferrihæmoglobin as a receptor for colour vision in the retina must therefore be regarded as a special provision to meet the need for a pigment which has a strong absorption in the region of wave-lengths greater than 6000 angstroms. The possibility therefore arises that the quantity of it in the retina may in certain cases be either greater or less than that normally present and that it may even indeed be totally absent in some cases. In the latter event, the person concerned would be red-blind. On the other hand, a deficiency would result in colour vision of the type known as protoanomalous, while an excess would result in deuteranomalous vision. In the former case, the result would be a closing up of the luminous efficiency curve away from the red so that its asymmetry of form becomes less pronounced. In the latter case the luminous efficiency curve would open out towards the red and its asymmetry of form become more pronounced.

As was remarked earlier, the dip in the hue discrimination curve normally observed at 5900 angstroms arises from the large fall in the strength of the absorption of light by ferro-hæmoglobin which occurs in the region, while at greater wave-lengths, the operative pigment is ferrihæmoglobin. If, however, the latter is not present in sufficient quantity, the change in hue with change of wave-length would be less rapid, in other words, the hue discrimination curve would move upwards. These results are in agreement with the ascertained facts of the subject.

THE INDIAN ACADEMY OF SCIENCES

THE Twenty-Fifth Annual Session of the Indian Academy of Sciences was held on 16 to 28 December 1959, in Chidambaram, under the auspices of the Annamalai University. The session which was attended by a large number of distinguished scientists, Fellows of the Academy and delegates from all over India was inaugurated by Rajah Sir M. A. Muthiah Chettiar, Pro-Chancellor of the Annamalai University. Mr. T. M. Narayanaswamy Pillai, Vice-Chancellor of the University, welcomed the gathering.

Sir C. V. Raman, President of the Academy, in his address "On the Sensations of Colour and the Nature of the Visual Mechanism" disclosed an entirely new approach which he had made to the solution of the fundamental problems of light, colour and vision. Novel ideas regarding the origin of colour, the nature of the visual mechanism which enables it to be perceived and finally, regarding the materials present in the human retina which enable the mechanism to operate, were put forward by him. These materials have been identified as the four visual pigments, *viz.*, (1) lutein, also known as xanthophyll, (2) hæmoglobin, (3) oxy-hæmoglobin and (4) methæmoglobin. The presence of lutein in the retina has long been known and it has been identified as responsible for the yellow pigmentation of the macular region. The other three substances are pigments present in human blood, and since the retina is richly nourished by blood vessels it is justifiable to assume that they are present in the retina and play a significant role in its functioning. According to the new theory presented by Sir C. V. Raman, the known data regarding colour sensitivity and colour mixture can be satisfactorily explained in terms of the absorption spectra of these materials. (Full report of the address appears on p. 1.)

The second day of the Session opened with a symposium on "Tectonics in Relation to India" under the Chairmanship of Dr. S. Bhagavantam. Dr. M. S. Krishnan who led the symposium dealt with the structure of the earth's crust in general and the tectonic features of India and its neighbourhood in particular. He pointed out how these features could best be explained by the hypothesis of continental drift associated with the names of Taylor, Wegener and Du Toit. A detailed account of Dr. Krishnan's paper will appear in a later issue of *Current Science*. Dr. C. Mahadevan and Mr. U. Aswathanarayana in their paper on "Age Levels of Precambrian Orogenic Cycles of India", presented the Precambrian age data obtained by Pb-U-Th, alpha-helium and Rb-Sr methods. The following cycles have so far been delineated: Dharwar 2300 ± 100 M.Y.; Eastern Ghats 1625 ± 75 M.Y. Mahanadi 1350 ± 200 M.Y.; Satpura 955 ± 40 M.Y.; Delhi 735 ± 30 M.Y.; and Kishengarh 580 ± 20 M.Y. It was shown that these cycles have equivalents in several parts of the world. Dr. S. Balakrishna gave the results of detailed studies on the granitic rocks of Hyderabad with special reference to tectonics, deformation and elasticity. Mr. N. A. Vemban presented a paper on "Structure and Tectonics of the Manganese Ore Belt of Madhya Pradesh and Adjoining Parts of Bombay".

In the afternoon Session on the second day at the scientific meeting in Section A, a number of papers were presented and discussed. Dr. S. Bhagavantam in his paper on "Elasticity of Metals and Alloys" drew attention to the differences in the elastic behaviour of representative metal single crystals which crystallize with cubic symmetry and explained how these differences could be connected with the electron zonal structures. The other papers presented at the meeting were "Theory of the Dispersion of Infra-red Radiation in Crystals" by Mr. S. Pancharatnam; "Design and Operation of a Molecular Oscillator" by Dr. H. G. Venkatesh; "Photo-production of Pion Pairs by Polarized Nucleons" by Dr. S. K. Srinivasan and "Intensity Relations in Raman Effect" by Dr. K. Venkateswarlu.

On the third day of the session there was a symposium on "Chemical and Biological Control of Insect Pests". Dr. K. Ramiah who acted as Chairman of the symposium in his introductory speech pointed out that the control of crop pests is not the concern of individual crop growers only but that it is a collective and co-operative work. He dealt with the control of insect pests with special reference to rice crop and compared the work that is being done in this field in Japan and other East Asian countries. He stressed on the need for more intense investigations on the biogenesis and bionomics of insects to make biological control of crop pests more effective.

Dr. M. Puttarudriah who led the symposium reviewed, on the basis of recorded results of experimental trials, the present position of chemical control of insect pests attacking various crops. He cautioned about the need for great care in the use of powerful organic insecticides

since their indiscriminate use is likely to produce deleterious effects, firstly in developing in the target species a total or partial resistance to the chemical and secondly, in producing adverse effects on beneficial parasites. Use of selective insecticides such as Schradan and Aramite is advocated to overcome this risk. Dr. K. V. Joseph gave an account of the present position with regard to the control of rice pests in Kerala. The major pests are the stem-borers (particularly *Schœnobius incertulas*) against which no satisfactory control has so far been evolved, the swarming caterpillar (*Spodoptera mauritia*), the rice bug (*Leptoconisa acuta*), and the rice hispa (*Hispa armigera*). The latter three have more or less been successfully tackled by sprays and dusts of DDT and BHC. Dr. Sardar Singh spoke about "Effective Pest Control through Spray Programmes" and gave an account of the results of the spray programmes for various crops that have been initiated in the Punjab in 1956.

In the scientific meeting at the afternoon Session on the third day the following papers were presented: "The Yeast Nucleus" by Dr. M. K. Subramaniam; "Studies on the Microbial Spoilage of Canned Food" by Dr. G. Rangaswami and Mr. R. Venkateshan; "The characteristics and Questionable Taxonomic Position of the Oxalate Decomposing Bacterium, *Vibrio extorquens*" by Dr. J. V. Bhat; "Conservative Systems in Physics" by Prof. G. N. Ramachandran, "Certain Fundamental Equations in the Study of Daylighting in Buildings" by Mr. T. N. Seshadri "Latent Heat of Vaporisation and Composition" by Dr. R. D. Desai.

There were two public lectures in the evenings of the 27th and the 28th. The first lecture was on "Supersonic Flight" by Dr. P. Nilakantan and the second was on "Radio Astronomy" by Dr. S. Bhagavantam.

Two excursions were arranged on the 29th, one to the Neyveli Lignite Project and the other to the Estuarian Biological Laboratory at Porto Novo. A large number of Fellows and Delegates took part in these excursions.

At the business meeting held on 26-12-1959 the following were elected to the Academy:

Honorary Fellows: Prof. Albert Frey-Wyssling, Switzerland; Prof. Nikolai Nikollaevich Semenov, USSR; Prof. Arne Wilhelm Kaurin Tiselius, Sweden.

Fellows: Miss Anna Mani and Messrs. S. S. Dharmatti, G. S. Puri, G. Rangaswami, T. H. Rindani, K. S. Thind, M. K. Vainu Bappu.

CENTENARY OF SPECTRAL ANALYSIS*

ON the 20th October 1959 one hundred years ago, Robert Kirchhoff and Wilhelm Bunsen announced the result of their "Investigations on the Spectra of Coloured Flames", and in doing so laid the scientific basis for the development of spectral analysis. In their report, the important proof has been furnished for the first time that the Fraunhofer "D"-lines in the solar spectrum coincide with the two spectral lines which occur in the spectrum of a Bunsen-flame coloured with sodium chloride. From this result and from further investigations about the origin of the Fraunhofer lines, Kirchhoff and Bunsen deduced that the presence of the dark "D"-lines in the solar spectrum permit the conclusion that there must be a sodium content in the Sun's atmosphere. This practically provided—on the basis of an atomic absorption spectrum—the first qualitative spectral analysis by way of identifying an element by its spectrum. Even though it could not then be definitely stated that the clear correlation thus established between a spectrum and an element was the final clue leading to the atom, the discoverers of the spectral analysis, nevertheless, fully assessed the value of its great practical significance in that they declared:

> "Chemistry cannot show any reaction which could be compared even remotely with the spectro-analytical determination. The eye can, for example, even perceive 3×10^{-7} mg Na..... The positions the spectral lines occupy in the spectrum presume a chemical property which is as immutable and as fundamental as the atomic weight of substances and can therefore be determined with an almost astronomical accuracy. Yet, what imparts a specific importance to the spectro-analytical method is the fact that it extends almost to infinity, the limits up to which chemical characteristics about matter were restricted so far."

These statements are valid to this day as soon as it is intended to characterise the importance of spectro-analytical methods of investigation. Yet, promising as the new research method seemed to be, it took a long time, a

* In Commemoration of its Discovery by Robert Kirchhoff and Wilhelm Bunsen.

many obstacles placed in its way had to be removed, before industries envisaged to employ it in their laboratories. The result was that the method was resorted to only by some untiring research scientists on a purely scientific level, whilst the overwhelming majority of chemists practically disregarded so promising a method.

"One can see, it is a wearisome and time-wasting process which in addition requires special instruments and training. It will therefore be applied on rare occasions only." Thus wrote H. KAYSER in 1910 in his *Manual* of Spectroscopy. His verdict on the quantitative analysis is best expressed by the following sentence :

"When summarising all the investigations discussed, I came to the conclusion that quantitative spectroscopic analysis has proved to be impracticable."

As late as in 1923, DE GRAMONT laments that French chemists have a latent fear of spectral analysis and that there still are instances of prominent physicists even refusing to inform themselves on any kind of spectral analysis, publicly declaring that spectral analysis since the times of KIRCHHOFF and BUNSEN had been a maldevelopment which had made no progress whatsoever from a practical point of view.

Yet, only one year later, F. LOWE drew the attention of his German professional colleagues to "A forgotten method of quantitative spectral analysis" with the result that the quantitative spectro-chemical emission analysis succeeded in finding general introduction in the metal-processing and metal-producing industry here as well as in a few other countries where in some isolated quarters it had proved its worth.

From that time on the development of the spectral analysis is characterised particularly by ever more perfected methods and procedures of investigation. Especially the use of new, highly sensitive radiation detectors (photoelectric cells, thermo couples) in conjunction with efficient amplifying equipment resulted in the design of "photoelectric spectrophotometers" which, for many purposes, provide a direct, and frequently automatically recorded, indication of the intensity of spectral lines or of the quantities of certain elements contained in the tested specimens.

Yet, even apart from the briefly indicated struggle for its practical applicability, the spectral analysis was the subject of eager activity on the part of investigators. As a result of the attempts at interpreting the emission spectrum of the atomic hydrogen the knowledge was arrived at that beyond furnishing the basis for the chemical identification of elements, the spectrum also represents the most striking means of disclosing information about the structure of the atom itself. Thus, after the pioneer work of KIRCHHOFF and BUNSEN, and with the assistance of many investigators not mentioned herein, a bridge has been built reaching from the spectral line to the atomic structure, and across which a road to modern atomic research leads even to this day.—OSWALD SCHIEK, *Veb Carl Zeiss, Jena.*

GROUND STATE OF THE C_2 MOLECULE

MOLECULAR spectroscopists who are familiar with the analysis of the well-known Swan bands ($^3\pi_g - {}^3\pi_u$) of the C_2 molecule have all along considered the $^3\pi_u$ state as the ground state of the molecule. Apart from the main reason for this assignment, *viz.*, that the Swan bands are the easiest to be observed in absorption, there are other reasons also as for example, (i) the observation of the Swan bands in emission from comets in which the emission is believed to be due to a resonance fluorescence process, and (ii) the occurrence of the Swan bands from C_2 molecules deposited in an inert gas matrix at 4·2° K. But the observations of E. A. Ballik and D. A. Ramsay (*J. Chem. Phys.*, 1959, 31, 1128) seem to indicate that the $^1\Sigma_g^+$ state is the ground state for the C_2 molecule, in the gas phase at least. They base their assignment on the rotation vibration analysis of a new band system of the C_2 molecule in the near infra-red, in emission from a carbon furnace. An analysis of the perturbations of two levels involved in this emission band leads to the result that $^1\Sigma_g^+$ state lies below the $^3\pi_u$ state by about 610 cm.$^{-1}$ In this connection it is interesting to note that the Swan bands have never been observed in interstellar space. According to the present observation if C_2 is a constituent of the interstellar medium its presence should be sought by means of band systems involving $^1\Sigma_g^+$ state and not by means of the first lines of the Swan system.

INDUSTRIAL HYGIENE*

INDUSTRIAL Hygiene (I.H.) has been defined as the art and science of safeguarding and preserving the health and well-being of industrial workers. These ends it seeks to achieve through, (i) recognition and evaluation of environmental causes that are likely to be source of illness or injury, (ii) improvement of work environments and (iii) enforcement of the established laws, rules and procedures relating to I.H. and safety. It, therefore, attempts to anticipate adverse environmental conditions and to device engineering control measures to prevent injury to life or limb and, eventually when possible, to eliminate related occupational hazards and diseases. I.H. constantly seeks to absorb beneficial techniques and practices as they emerge. To be effective it enlists intimate collaboration between Industrial Hygienist, Safety Engineer, responsible medical authority and other allied disciplines such as Physics, Chemistry, Biology, Psychiatry and Engineering.

Mankind owes a great debt of gratitude to the martyred orphaned-child-workers in the cotton mills and mines of U.K. in the 18th century. Child-labour was a plentiful commodity then. Their deplorable state and the unconscionable manner in which they were exploited inspired the earliest Factory Act of 1802 which became the harbinger of scores of Factory Acts in U.K. and hundreds throughout the world. Labour legislation in U.K. set the pace and was later emulated in Germany, France, America and elsewhere.

In U.S.A. factory inspection was first introduced in 1877 in the State of Massachusetts. The Federal Government adopted compensation laws for civil servants in 1908. New Jersey led the States in passing a similar law for industrial workers in 1911. The first important federal act to control an occupational disease, resulting from the use of phosphorus in the manufacture of matches, was passed in 1912 by the levy of a prohibitive tax. Wisconsin made occupational disease compensable in 1919 and now similar laws are in the Statutes of the majority of States. Because labour occupies a position of dignity and is well organised, and management is alert, there has been ample opportunity to study the adverse effects of occupational environments and to take corrective steps. Besides, the worker in the U.S.A. has come to expect and, in fact, demands a safe, healthful and relatively clean and stress-free work-place and will not accept a dirty or dangerous occupation. In recent years, for example, even the foundry industry has joined the march of progress by providing clean as well as healthy work environments. Public opinion and the stringent labour and compensatory laws would suffer few employers who might treat the workers as a commodity freely purchasable on the market. These factors, coupled with rapid strides in technology, informed management, and labour fully conscious of its rights, have all led to the now axiomatic proposition that a worker is an efficient producer *only* when his working environment is congenial, co-operative, secure and satisfying—in short, friendly. Besides, or perhaps precisely because of this recognition, substantial pioneer work has been done in the field of I.H., in a systematic and organised fashion. With the passage of the latest U.S. workmen's compensation laws the responsibility of traumatic injuries and occupational diseases has shifted from the individual worker to the industry.

The recency of the development of I.H. in U.S.A., in an organised manner, may be gleaned from a few salient facts. Even though the Division of I.H. and sanitation of the U.S. Public Health Service was organised in 1915, its activities were relatively minor and till 1936 were largely confined to research of a statistical and medical nature. Up to that year there were only 5 State departments of health and 3 State departments of labour, in the entire Union of 48 States. By 1946, 41 out of 48 States had organised State agencies to advance I.H. through the enforcement of control measures against pollution of air, contamination of water as a result of draining industrial wastes, nuisance of industrial noise and, finally, to insure enforcement of factory laws relating to light, heat, sanitation, safety and other protective measures. As a further check a number of States now prescribe thorough medical examination, both pre-employment and periodic, for workers to be engaged in potentially hazardous occupations.

In the U.S.S.R., during a little over forty years of its existence, the technological and scientific advance has been phenomenal. Their scientists and technicians have made spectacular contributions to all fields of human endeavour and now they have rocketed the moon. The mental and physical well-being of the workers and working conditions have received special attention from the technical personnel as well as their government. This is manifest in their scientific studies of occupational hazards and

* *Industrial Hygiene and Toxicology*, Vol. I—General Principles. Edited by F. A. Patty. (Interscience, New York), 1958. Pp. xxviii + 830. Price $ 17.50.

t the means of promoting industrial health rough such diverse, and yet related, research rganisations as the Moscow Institute of Indus- ial Diseases, the Pavlov Institute, the Lenin- rad Institute of Safety, Hygiene and Technique, e State Scientific Institute of Labour Protec- on and the Moscow Central Institute of Nutri- on. Thus U.S.S.R. attaches special importance improved labour conditions in order to insure gh morale and maximum efficiency for their anned productivity. I.H., therefore, constitutes *raison d'etre* of all the Soviet enterprises.

It is against such a historical background at the significance of this book, *Industrial ygiene and Toxicology* can be best appreciated. is the first of the three volumes, and deals ith the general principles. (Volume II : *Toxi- ology* and Vol. III : *Industrial Environmental nalysis*). It is an all American book. It ntains 31 Chapters contributed by 18 special- ts. This distinguished company of authors drawn from the U.S. Public Health Service, ureaus of Standards and Mines, noted Research nd Educational Institutions and leading Indus- ies. It contains a comprehensive and syste- atic treatment of industrial hazards and their uses and of their detection, prevention, con- ol and elimination. The original edition ppeared in 1948 and this, the second edition, 1958. During the decade phenomenal advan- s have been made in pure and applied sciences. ecause of the development of nuclear power nd the growing application of isotopes, tech- ology has taken a dramatic leap. The posi- on of industrial worker has potentially become ore difficult and dangerous. The recognition, valuation and control of *ionizing radiation* xposures and the inhalation of radioactive ses have aroused unprecedented concern r all organic life. Thorough mastery of these nd other hazardous contaminants has there- re become an imperative to protect life. At ng last, Human Engineering and I.H. which ad so long and so greatly merited attention, ve received up-to-date treatment in this new ition. This composite work is an eloquent xpression of an integrated approach and team- irit to achieve a common objective.

The volume is edited by Frank A. Patty, irector of I.H. Department of the General otors Corporation. He draws from his rich xperience to contribute five chapters, namely, H. Prospect and Retrospect, Methodology of H. Surveys, Action of Toxic Materials, Atmo- heric Contaminants, Respirators and Respira- ry Protection Devices.

The chapter on Human Engineering and dustrial Safety, written by Ross A. McFarland, Director of the Health and Safety Centre, School of Public Health at Harvard, carries the hall-mark of critical comprehension and lucid exposition. He considers as indispensable the utilisation of basic data on the range of the motion of head, upper arm, forearm, hand, thigh, lower leg and foot and the forces applicable in different body positions, for control design. He elaborates on the application of anthropo-metric and statistical data for arriving at proper human sizings for the purposes of design. He considers instruments and controls as extensions of the nervous system and body appendages of the operators. Therefore, he advocates the designing of equipment and working areas in keeping with human capabilities and limitations and consistent with the anatomical, physiological and psychological characteristics of the operators.

The chapter on Pulmonary Dust Diseases deals with classification and properties of dust, the anatomical and physiological factors of importance in injury, and pulmonary fibrosis. Periodic check of workers is recommended since no other technique is available to prevent dust diseases. The chapter on Occupational Dermatoses covers most occupational diseases.

Of particular and timely interest to industries is the chapter on Radiant Energy. It discusses the different concepts of injury caused by radiation, penetrating ionizing radiation and protection from Gamma and X-rays, infra-red radiation, corpuscular radiation (Alpha and Beta Particles, Protons and Neutrons) and poisoning from Radioisotopes.

The chapter on Industrial Noise and the Conservation of hearing covers, in considerable detail, the fundamentals of noise and its transmission, the ear and the measurement of hearing and, finally, noise control. A valuable and concise chapter on Lighting for Seeing is contributed by two authorities from the Lamp Division, of the G. E. Co. at Cleveland. In a table they furnish an authoritative and specific recommended values of illumination for different types of work and work areas.

Air pollution is the most serious health and economic problem in modern industrial communities. There is no way of determining the cost in human life, disease and unhappiness due to this cause. As for material losses, for instance, the U.S. Geological Survey places its damage to merchandise and buildings in that country at 500 million dollars annually. (Just a glimpse of relevant history : in the U.K. the first smoke abatement law was passed by Edward I in 1273 to protect the people's health from pollutents. As early as 1306, by Royal

Proclamation, the burning of coal was prohibited in London. An owner of industry disobeyed the proclamation, was tried, found guilty and beheaded. In early February 1959, heavy smog persisted in London for five days, caused widespread infection and unprecedented crowding of hospitals, and took an unusual toll of life and affected the health of a large percentage of Londoners. The irony of the situation is that even though coal, gas and electricity are nationalised and are administered by the same Minister, co-ordination of industries and control of smoke appears difficult since the maze of chimneys over the London houses continue to smoke, unabated. The chapter on Air Pollution traces its history through advancing industrialization and urbanisation.

Because of the adverse effects of heat on comfort, safety and health of workers and, consequently, on production, heat and allied controls have merited four chapters. They are : Air Cleaning, Air Conditioning, Ventilation and Heat Control in the Hot Industries. All these chapters are of very special interest to us in India where, for a major part of the year, the temperature and humidity ranges lie in the physiologically harmful zone. Medical authorities tell us that in this zone increasing degree of psycho-physiological disturbances are noted as the level of stress rises with heat and humidity. In such a situation human organs exert their automatic controls. A substantial part of the outgoing blood from the heart is diverted, *for cooling purposes*, to all the extremities of the body. Naturally, that results in a deficiency of supply to the brain thereby affecting its work of discrimination, integration and precision in movement, with consequent sluggishness, errors and accidents. The high correlation between accident rates and high temperatures is attributed to this factor. Therefore, the author concludes, that the advantages of air-conditioning should be seriously considered for all industrial operations carried out for any length of time, under conditions of high temperature.

This composite volume is logically conceived, psychologically developed and is handsomely got up. It makes excellent use of graphic materials to supplement the clarity of the written word. It carries a good index. Most chapters include tables furnishing vital information—both factual and technical. For the benefit of those who desire to pursue a subject in greater detail, each chapter furnishes relevant references. The inclusion of a section recounting the activities and contributions of ILO and WHO in this volume would have be pertinent and welcome. However, it is a valu able reference and should be at the elbow every industrial hygienist, safety, sanitation an production engineer, and alert industri manager. It is a must reference for the librari of Engineering Colleges and Industries.

A word about the prospects of utilisin the I.H. techniques in India. The absenc alleged or real, of the concern of health, safet well-being and desirable working environme in a factory where the worker spend nearly 25% or more of his weekly tim can prove a corroding factor to pro ductivity. This problem is particular aggravated in our country by the climatic con ditions—high temperature and abnormal hum dity—for nearly 7 to 8 months in the yea Obviously, for lack of resources, we canno possibly apply, immediately, the techniques the I.H., so widely practiced in U.S.A. and well elaborated in the volume under discussio to our existing or developing industries. can, however, provide in our long-range pla for the manufacture of basic air-conditionin equipment with the view of air-conditioning o industries *as and when* we become self-relian Till such time it is suggested that such industrie as are running only one or two shifts and pro vide quarters to their workers in the factor neighbourhood, avoid work during the hotte part of the day. This could be achieved, con veniently, by bifurcating the day shift into morning and an evening period. Where second shift is essential, a night shift cou be introduced. A lead in these directions cou be given in a selected few of our new natio alised industries. The fertilizer-*cum*-heav water industrial unit at Naya Nangal incorp rates the latest in technology. Since it will operated by hydroelectric power, it wi provide the cleanest industrial area in Indi Naturally it will also offer the best opportunit for an extensive I.H. programme and coul therefore, be used as a model for emulatio In our new steel plants at Bhilai, Durgapur a Rourkela, the best known I.H. techniques ha probably been incorporated in their respecti designs by the Russians, British and West Ge mans, to insure effective control of contamina and to safeguard and preserve the health of t workers. These three large enterprises w provide comparable clinical data which cou be studied with advantage for essential appl cation or adaptability to other industri throughout our land.

BHOLA D. PAI

LETTERS TO THE EDITOR

A NOTE ON THE ORTHOGONAL POLYNOMIALS

In a previous paper, the author[1] proved two theorems concerning a Rodrigue's formula. Theorem (*b*) of that note admits of an extension which is presented here. Along with this, two theorems extending the recent work[2] of the author are also presented.

The notations are the same as in the previous papers :

Theorem (*a*).—The degree of X (an integer) which makes $p_m(n, x)$, an orthogonal set is $2m/n$ where n may be fractional.

Proof.—Let X be of degree r (an integer) and let all the derivatives up to and including $(m-1)$th of (ωX^s) be zero at (α, β). Consider

$$\langle p_m(n, x), p_{m'}(n', x)\rangle$$

$$= \int_\alpha^\beta \omega(x)\, p_m(n, x)\, p_{m'}(n', x)\, dx$$

$$= \frac{(-1)^{m'}}{k_{m', n'}} \int_\alpha^\beta \omega X^{n'} \left(\frac{d}{dx}\right)^{m'} p_m(n, x)\, dx$$

$= 0$ or a constant if $m' > (nr - m)$

since by cor. 1 or Theorem (*a*) of the note,[1] $p_m(n, x)$ is of degree $(nr - m)$.

Similarly

$\langle p_m(n, x), p_{m'}(n', x)\rangle = 0$ or a constant if

$m > (n'r - m')$.

These two conditions are together compatible if

$$nr = m + m'$$

$$n'r = m + m'$$

and hence

$$n = n'$$

and

$$r = \frac{m + m'}{n}.$$

This as yet does not indicate the orthogonality of the set $\{p_m(n, x)\}$. To make it orthogonal, one desires $p_m(n, x)$ to be of the precise degree m. Then, $nr - m = m$ or $nr = 2m$. Hence also $m = m'$ in the above.

Therefore

$$\langle p_m(n, x), p_{m'}(n', x)\rangle = \Lambda_{m, n}\, \delta_{m, m'}$$

and $r = 2m/n$ is an integer. This proves the theorem.

We observe that Theorem (*b*) of the note[1] referred to above is a special case of this theorem when $m = n$ so that $r = 2$.

In view of this theorem, some transforms analogous to the ones suggested recently[2] for the case $r = 2$ can be defined. Two theorems concerning them are stated without proof here, as they are quite similar to those in the work referred to above.

Defining either of the sequences of numbers

$$f_1(m, n) = T_1\{f(x)\} = \int_\alpha^\beta \omega(x)\, p_m(n, x)\, f(x)\, dx$$

and

$$f_2(m, n) = T_2\{f(x)\} = \int_\alpha^\beta p_m(n, x)\, f(x)\, dx$$

as the transforms of $f(x)$,

Theorem (*b*).—Let $f^{m}(x)$ be bounded and integrable in any closed sub-interval of (α, β). Then if

$$\operatorname*{Lt}_{x \to \alpha, \beta} \omega(x) \left(X(x)\right)^{m-n+1} f(x) \to 0$$

$$\operatorname*{Lt}_{x \to \alpha, \beta} \omega(x) \left(X(x)\right)^{m-n+1} f'(x) \to 0,$$

then

$$T_1\left\{\frac{1}{\omega(x)}\left(\frac{d}{dx}\right)\left[\omega(x)\left(X(x)\right)^{m-n+1} f'(x)\right]\right\} = T_1\{A(x)\, f(x)\}$$

where

$$A(x) = \left(X(x)\right)^{m-n}\left[(m+1)\left(\tfrac{1}{2}m - n\right) X^{(1)} + nh^{(1)} - (m-n)(\log \omega)^{(1)} X\right]$$

Or if

$$\operatorname*{Lt}_{x \to \alpha, \beta} \left(X(x)\right)^{m-n+1} f(x) \to 0$$

$$\operatorname*{Lt}_{x \to \alpha, \beta} \left(X(x)\right)^{m-n+1} f'(x) \to 0,$$

then

$$T_2\left\{\left(\frac{d}{dx}\right)\left[\left(X(x)\right)^{m-n+1} f^{(1)}(x) + \left(X(x)\right)^{m-n} h(x)\, f(x)\right]\right\} = \left(X(x)\right)^{m-n} h(x)\, f(x)\Big|_\alpha^\beta - T_2\{A(x)\, f_1(x)\}.$$

We may state the inverse of the first of the operational relations of Theorem (*b*) as:

Theorem (c).—Let $f(x)$ be a function of bounded variation in every closed sub-interval (α, β) and

$$\int_{\alpha}^{\beta} f(x)\,\omega(x)\,dx = 0 = f_1(0, n).$$

Let

$$R \equiv \frac{1}{\omega(x)}\left(\frac{d}{dx}\right)\left[\omega(x)\left(X(x)\right)^{m-n+1}\left(\frac{d}{dx}\right)\right]$$

If

$$R[g(x)] = f^{n}(x),$$

then

$$T_1\{f(x)\} = T_1\{A(x)\,R^{-1}[f(x)]\}$$

and

$$T_1^{-1}\{f_1(m, n)\} = A(x)\,R^{-1}[f(x)]$$

$$= A(x)\left[\int_0^{\bar{x}} \frac{ds}{\left(X(s)\right)^{m-n+1}\omega(s)} \times \int_{\alpha}^{x} \omega(t)\,f(t)\,dt + C\right]$$

where C is a constant determining $R^{-1}[f(x)]$ when $m = 0$.

In conclusion, it is a great pleasure to record here the author's grateful thanks to Prof. R. S. Krishnan for his keen interest in the work and for his constant encouragement.

Dept. of Physics, A. K. RAJAGOPAL.
Indian Institute of Science,
Bangalore-12, *October* 9, 1959.

1. Rajagopal, A. K., *Proc. Nat. Inst. Sci.* (Delhi), 1958, **24 A**, 309.
2. —, *Proc. Ind. Acad. Sci.*, 1959, **50 A**, 143.

POTENTIAL CONSTANTS OF $VOCl_3$

USING Wilson's[1] F-G Matrix method the potential constants of Vanadium Oxytrichloride are calculated. The Infra-red and Raman data of the molecule determined and assigned by Miller and Cousins,[2] and electron diffraction data taken from Landolt and Bornstein tables[3] are used.

Type A_1: 165, 408, 1035 cm.$^{-1}$ (Polarised).
Type E: 129, 249, 504 cm.$^{-1}$ (Depolarised).
$V = O = 1{\cdot}56$ A, $V - Cl = 2{\cdot}12$ A,
$O = V - Cl = 108°\ 12'$, $Cl - V - Cl = 111°\ 17'$.

The following force constants are obtained:
$f_D = 7{\cdot}85 \times 10^5$ dynes cm.$^{-1}$
$f_{Dd} = 0{\cdot}390 \times 10^5$ "
$f_d = 1{\cdot}409 \times 10^5$ "
$f_{dd} = 0{\cdot}741 \times 10^5$ "
$f_\alpha + f_\beta = 0{\cdot}451 \times 10^5$ "
$f_{\alpha\alpha} + f_{\beta\beta} = -\ 0{\cdot}118 \times 10^5$ dynes cm.$^{-1}$
where f_D, f_d, f_α and f_β are the V = O stretching constant, V − Cl stretching constant, Cl − V − Cl bending constant and Cl − V = O bending constant respectively while f_{Dd}, f_{dd}, $f_{\alpha\alpha}$, $f_{\beta\beta}$ and interaction constants.

The frequencies of vibration are calculated using these force constants and are listed below
Type A_1: 165, 408, 1036 cm.$^{-1}$
Type E: 129, 251, 503 cm.$^{-1}$

The agreement between observed and calculated frequencies is quite satisfactory. The V = O stretching constant $f_D = 7{\cdot}85 \times 10^5$ dynes cm.$^{-1}$ compares favourably with the value $f_D = 7{\cdot}36 \times 10^5$ dynes cm.$^{-1}$ calculated from Molecular spectral data.

Details will be published elsewhere.

Department of Physics, P. BABU RAO.
S. V. Univ., Tirupati, K. SREERAMA MURTY.
November 25, 1959.

1. Wilson, E. B. (Jr.), *J. Chem. Phys.*, 1939, **7**, 1047; 1941, **9**, 76.
2. Miller, and Cousins, *Ibid.*, 1957, **26**, 329.
3. Landolt and Bornstein, *Atom und Molekular Phys.* Teil 1.

THERMAL EXPANSION OF CAESIUM IODIDE BY X-RAY DIFFRACTION AND THE GRÜNEISSEN'S PARAMETERS

THE thermal expansion of Cæsium iodide has been attempted by very few workers and no reliable data are available for it up to its melting point. Johnson, Agron and Bredig have determined the cell constant and hence the thermal expansion but their value at 25° C differs by about 20% from the precision X-ray determination of Rymer and Hambling.[2] The latter workers have given the value of the thermal expansion only between 22° C. and 36° C. It was thought desirable therefore to measure with all the usual precautions the above constants for CsI up to its melting point. The measurements were taken by employing a diffractometer, Geiger counter and a rate meter and verified by taking the pattern on an automatic chart recorder. The furnace used

was the one developed by the authors[3] in this laboratory. Accurate data on NaCl taken with the furnace and agreeing closely with the most reliable measurements of other workers have already been published. The same assembly being used for CsI, the measurements are expected to be equally reliable. The cell constants a_t are given in Table I.

TABLE I

Temp. $t°$ C.	a_t (Obs.)Å
30	4·564
70	4·573
120	4·582
171	4·595
270	4 615
306	4·629
381	4·648
436	4·660
498	4·680
542	4·696
575	4·707
603	4·719

The equation satisfying the curve of a_t against temperature is found to be

$$a_t = 4·5575 + 2·142\times10^{-4}t + 7·954\times10^{-8}t^2 \quad (1)$$

The coefficient of linear expansion α was calculated from the equation $\alpha = (1/a_t).(da_t/dt)$ and its values for different temperatures are shown in Fig. 1. Our value $47·8\times10^{-6}$ for α at 25° C.

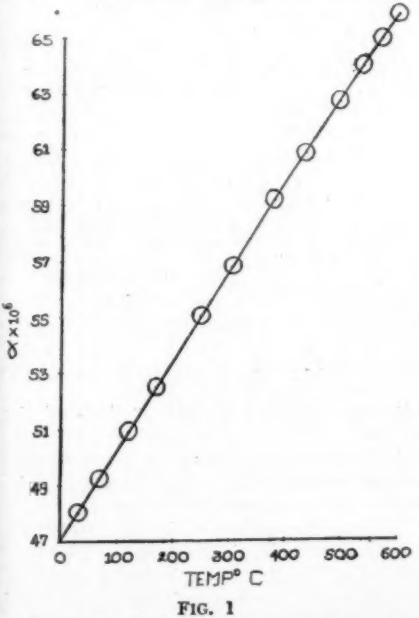


FIG. 1

agrees closely with that of Rymer and Hambling[2] (viz., $48·0\times10^{-6}$) and also with that of Baxter and Wallace[4] ($48·6\times10^{-6}$) determined by the displacement of toluene in a pyknometer.

Grüneissen's theory predicts volume increase according to the equation

$$3\frac{a_T-a_0}{a_0} = \frac{V_T-V_0}{V_0} = \frac{E/Q}{1-p.E/Q} \quad (2)$$

where E is the vibrational energy given by $E = 6RT\cdot D(\theta/T)$ and p and Q are constants. Hence equation (2) can be written as

$$\frac{a_0}{a_T-a_0} = \frac{Q}{2R}\cdot\frac{1}{T\cdot D(\theta/T)} - 3d \quad (3)$$

The value a_0 of the cell constant at 0°K can be calculated from the low temperature approximation to (2)

$$3\frac{a_{273}-a_0}{a_0} \approx \left(\frac{E}{Q}\right)_{273} \approx \left(\frac{3\alpha E}{C_v}\right)_{273} = \frac{3a_{273}\cdot 273\ D(\theta/273)}{C(\theta/273)} \quad (4)$$

where $C(\theta/T)$ is the Debye specific heat function. At low temperature Q can be written approximately equal to $(C_v/3\alpha)$.

Equation (3) shows that from the graph of

$$\frac{a_0}{a_T-a_0} \text{ against } \frac{1}{T\cdot D(\theta/T)}$$

the parameters $Q/2R$ and $3p$ can be obtained. They are given in Table II along with those calculated from the observations of Johnson *et al.* The constants for NaCl are given for comparison. The Debye characteristic temperature θ for CsI (95° K.) was taken from the compilation of experimental determinations by K. Lonsdale.[5]

TABLE II

	Q/2R	$3p$	Reference
CsI	.. $25·7\times10^2$	9·2	Johnson *et al.*
	$24·34\times10^2$	6·8	Authors
	$22·80\times10^2$	..	Equation 5
NaCl	.. $29·5\times10^2$	11	Eucken & Dannöhl[6]
	$28·2\times10^2$	..	Equation 5

The value of Q can also be calculated from the relation

$$Q = \frac{V_0}{\gamma\beta_0}, \quad (5)$$

where β_0 and V_0 are the compressibility and the molar volume at 0° K. Values of $Q/2R$ calculated from this equation are also shown in Table II, the values of V_0 γ and β_0 being taken from Born and Huang.[7]

M.G. Science Institute, Ahmedabad-9, December 16, 1959.

P. D. PATHAK.
N. V. PANDYA.

1. Johnson, J. W., Agron, P. A. and Bredig, M. A. *J. Amer. Chem. Soc.*, 1955, **77**, 2734.

2. Rymer, T. B. and Hambling, P. G., *Acta Cryst.*, 1951, **4**, 565.
3. Pathak, P. D. and Pandya, N. V., *Curr. Sci.*, 1959, **28**, 320.
4. Baxter, G. P. and Wallace, C. C., *J. Amer. Chem. Soc.*, 1916, **38**, 259.
5. Lonsdale, K., *Acta Cryst.*, 1948, **1**, 142.
6. Eucken, A. and Dannöhl, W., *Z. Elektrochem.*, 1934, **40**, 814.
7. Born, M., and Huang, K., *Dynamical Theory of Crystal Lattices*, Clarendon Press, Oxford, 1954. pp. 52–54.

HYDRATED COMPOUNDS OF URANIUM FROM URANIUM (IV) OXYCARBONATE

THE isolation of uranium (IV) oxycarbonate has been recently reported by us.[1] This compound undergoes simultaneous aerial oxidation and dehydration and results in the formation of pure uranyl carbonate. Carbonates are suitable starting materials for the preparation of different salts by their action with respective acids. The preparation of uranium (IV) oxycarbonate offers a new route for the preparation of uranium (IV) compounds in an expeditious and convenient manner. This method of preparing uranium (IV) compounds has been examined with a view to explore the nature of the compounds obtained, particularly the intensity of colour, crystal size, water of hydration and the formation of normal or oxysalts. Thus utilising the freshly prepared moist oxycarbonate as the starting material, uranium tetrafluoride, uranium (IV) oxynitrate, oxyformate, oxyacetate and the normal oxalate were prepared. In each case hydrated compounds were obtained.

Hydrated uranium tetrafluoride with 0·5, 2·0 and 2·5 molecules of water have been prepared.[2,3] We have prepared the compound both with 1 and 1·5 molecules of water.[4–6] In the present method, the compound is obtained as a fine green powder with one molecule of water by the action of 40% HF on the oxycarbonate.

Uranium (IV) oxyformate was prepared by Rosenheim[7] with 3 molecules of water. We prepared the compound as dark-green crystals and also in the powder form with 1·5 molecules of water.[8,9] When prepared from the oxycarbonate by the action of formic acid in presence of alcohol, it is formed with 3·0 molecules of water in a powdered form and a dirty-green colour, as obtained by Rosenheim.

The photochemical isolation of uranium (IV) oxyacetate monohydrate has been recently reported by us.[10] The reaction of acetic anhydride on the moist oxycarbonate results in the production of uranium (IV) oxyacetate with 2·5 molecules of water as a fine pale-green powder.

The isolation of oxysalts by the above process led us to attempt the action of oxalic acid, with a view to prepare the oxyoxalate, the compound which has been reported by us for the first time, during the photolysis of uranyl formate and oxalic acid.[11] But when oxalic acid solution was added to the oxycarbonate, the uranium (IV) dioxalate and not the oxyoxalate was obtained with the same 6 molecules of water of hydration as fine green crystals.

Uranium (IV) oxynitrate was prepared by Benrath[12] by the photochemical reduction of uranyl nitrate and alcohol. We prepared the compound by dissolving the oxycarbonate in minimum amount of 2N HNO_3 and adding excess of dioxan when a pale-green compound separated out. The compound on drying at room temperature in vacuum gave uranium (IV) oxynitrate with 4 molecules of water.

The analyses of the various constituents were carried out as reported earlier (*loc. cit.*).

Dept. of Chemistry, BALARAM SAHOO.
Ravenshaw College, D. PATNAIK.
Utkal University,
Cuttack, *September* 10, 1959.

1. Sahoo, B. and Patnaik, D., Communicated to *Nature*.
2. Ruff, O. and Heinzelmann, A., *Z. anorg. Chem.*, 1911, **72**, 64.
3. Chlopin, V. G. and Jaschtschenko, M. L., *Bull. Acad. Sci. U.R.S.S.*, 1942, 87.
4. Sahoo, B. and Patnaik, D., *Curr. Sci.*, 1959, **28**, 16.
5. Patnaik, D. and Sahoo, B., *Proc. Ind. Acad. Sci.*, 1959, **49**, 200.
6. Sahoo, B. and Patnaik, D., *Curr. Sci.* (under publication).
7. Rosenheim, A. and Kelmy, M., *Z. Anorg. U. allgem. Chem.*, 1932, **206**, 34–43.
8. Sahoo, B. and Patnaik, D., *Curr. Sci.* 1958, **27**, 243.
9. — and —, *J. Ind. Chem. Soc.*, 1959, **36**, 135.
10. Tripathy, K. K., Sahoo, B. and Patnaik, D., *Ibid.*, (under publication).
11. Patnaik, D. and Sahoo, B., *Curr. Sci.*, 1958, **27**, 292.
12. Benrath, A., *Z. Wiss. phot.*, 1917, **16**, 258.

REMARKS ON PINGUITE

DANA classifies Pinguite among the varieties of chloropal with the following description: ".. is siskin- and oil-green extremely soft, like new made soap, with a slightly resinous lustre not adhering to tongue". He considers Pinguite as '.. really a member of the chlorite family .. But some Pinguite is chloropal *M.A.* 10, 23). Anyhow, Pinguite is a hydrated silicate of ferric iron with the general formula $H_4Fe_2Si_2O_9$ .... and is included in the montmorillonite family of the group of clay minerals.

Pinguite collected from Borborema region of the North-East of Brazil has been taken for study and the results are given hereunder.

Greasy-green to oil-green in colour and massive in habit it has a soft soapy feel. Easily powdered by finger nail it is friable, has a low specific gravity of 1·8 ± variations due to the presence of magnetite specks and altered product-limonite, as patches. Earthy to dull in lustre with a greasy shine, it is fine clayey mass when seen under the microscope. Practically it is opaque though some grains are partly translucent.

Extreme care is exercised to get a pure sample for study by X-rays. The lines are seen somewhat diffused, though they permitted accurate measurements. After the necessary corrections the interplanar spacings are obtained. In Table I the three intense lines are compared with the values obtained for a chlorite and nontronite (variety of chloropal).

TABLE I

Pinguite Borborema	Nontronite (Urban)	Chlorite Simplon Tunnel
15·3	15·4	14·0
4·54	4·56	4·66
1·515	1·518	1·545

Generally classification of the clay minerals is made by the basal reflection. Considering the basal 14 KX of chlorites, obviously Pinguite cannot be classed as a member of the chlorite family. On the other hand, nontronite shows great similarities including the characteristic 15 Å reflection. Thus the pinguite could be classified as a variety of chloropal.

An attempt is made to observe the thermal behaviour of this mineral. Water is lost in stages, and the first 110° has recorded 12·66%, by 600° — 18·24%, and at 1000° the total has gone up to 19·54%. It is possible that the first loss is due to the interlayer water content and later the structure was broken down, similar to nontronite. The water content in Pinguite seems to be variable, and thus detailed thermal studies applying the DTA technique are under progress.

Thanks are due to Professor Dr. Theodor Hügi of the University of Bern, Switzerland, for kindly arranging the X-ray photos.

Mineralogical Laboratory, A. BHASKARA RAO.
Institute of Geology,
University of Recife,
Recife, Brazil,
October 24, 1959.

1. Bhaskaea Rao, A., "Firsure minerals of Simplon Tunnel (North-Eastern Part)," *Thesis for Ph.D.*, University of Bern (under publication), 1957.
2. Dana's *Text-Book of Mineralogy*, John Wiley & Sons, Inc., 4th. Ed., 1957.
3. Grim, R. E., *Clay Mineralogy*, McGraw-Hill Book Company, Inc., 1953.
4. Hey, M. H., *An Index of Mineral Species and Varieties Arranged Chemically*, British Museum (Natural History), London, IInd. Ed., 1955.
5. Urban, Heinz, *Röntgenkartei Zur Bestimmung Von Ton Und Sediment Mineralien*, Verlag Gustav, Felle-Nottuln. Kettwig/Ruhr, 1954.

QUARTZ VEINS IN THE YELLANDLAPAD ROCKS

IN an earlier paper the author[1] has described certain replacement granitic dykes in the migmatites of Yellandlapad. During a further investigation of the same area, the author noticed the occurrence of quartz veins in the country rocks which include granites, quartzofelspathic gneisses, amphibolites, etc. In their field occurrence these veins present a number of characteristic features. They vary in size from a few inches to those which are tens of feet across. However, along the strike, some of the quartz veins can be followed for considerable distances. It is singularly interesting to note that wherever quartz veins occur, they are perfectly conformable with the foliation of the adjacent rocks. Two types of occurrence of quartz veins are found to be particularly interesting from the point of view of their origin. One is the occurrence of quartz veins in the granitic rocks of Yellandlapad and the other is their occurrence in the amphibolites of Bethampudi. These two types are shown in Figs. 1 and 2.

In the first type, the host rock is a porphyritic grey granite consisting of greyish white felspars (both oligoclase and microcline) white quartz and ferromagnesians (biotite and chlorite with some epidote). The vein is about a few inches in thickness and is identical in appearance to the quartz dispersed in the granite host. The contact between the veins and granite is not sharp but gradational and interlocking. Some of the minerals along the contact (felspars and ferromagnesians) are common both to the vein and granite. A few of the ferromagnesian mineral streaks in the granite having a particular trend continue absolutely undisturbed into the quartz veins. Within the vein itself there are mafic segregations. These streaks and segregations are an inherent part of the granite

and not post 'consolidation' fracture fillings. In the Bethampudi amphibolites the veins are again in conformity with the schistosity of the host. The amphibolites consist of green hornblende ($2V = 45°$, $Z \wedge C = 20°$), plagioclase with composition An 30-35% and some amount of quartz. One of the very interesting features is the occurrence of hornblende streaks right in the body of the quartz vein itself retaining perfect conformity with the hornblende of the amphibolite host. The optical properties of streaky hornblende are identical to those present in amphibolite. Further in the amphibolite host itself there are thin stringers of quartz whose trends are parallel to the schistosity and which are identical in appearance to the vein quartz. In the immediate neighbourhood of quartz vein, the amphibolite does not contain quartz and there is a great clustering of amphibole prisms.

FIG. 1. Quartz vein in granite (near Yellandlapad). Note the gradational boundary between the quartz vein (left) and granitic rock (right). Some of the ferromagnesians of the granitic host continue undisturbed into the vein. About half natural size.

Many of the features given above (in the occurrence of quartz veins) have been cited by Stuart Webb,[2] Ramberg,[3] Read[4] and others. The quartz veins in the granitic rocks of Yellandlapad have many features similar to the veins in Carn Brea granite described by Stuart Webb who favoured a replacement origin for such veins. Describing the kyanite bearing quartz veins in pelitic schists of Shetland Islands Read noted the poverty of quartz in the immediate neighbourhood of the veins and considered the veins to be due to endogenous secretion during metamorphism, a process of solution and recrystallization through a medium of aqueous pore fluids. The author also favours the view that quartz veins in the Yellandlapad and Bethampudi rocks might have originated by metamorphic differentiation which apparently acted in conjunction with the granitization affecting the area. Even Ramberg[4] finds the place of metamorphic differentiation somewhere between isochemical recrystallization and large-scale metasomatism in regionally metamorphosed complexes.

The author is grateful to Dr. S. Balakrishna for valuable suggestions and help given throughout this investigation.

FIG. 2. Quartz vein in amphibolite (1 mile to the West of Bommanpalle). Note the hornblende streaks in quartz vein in perfect conformity with the foliation of the amphibolite and margins of the vein. Also note the thin stringers of quartz in amphibolite.

Geology Department, Y. JANARDAN RAO.
Osmania University,
Hyderabad-7 (A.P.),
September 14, 1959.

1. Janardan Rao, Y., *Curr. Sci.*, 1959, **28**, 242.
2. Stuart Webb, J., *Geol. Mag.*, 1946, **839**, 177–86.

3. Ramberg, H., *Chicago Univ. J.*, Chicago Press, 1952, 252.
4. Read, H. H., *Min. Mag.*, 1933, 23.

STUDIES ON EQUILIBRIUM RELATIVE HUMIDITY (E.R.H.) FOR ONION POWDER

DURING the course of our investigation on the dehydration of onions, a survey of literature revealed little published information on the packaging requirements or the *Equilibrium Relative Humidity* (E.R.H.) data on onion powder. The present report covers this important aspect of packaging of onion powder.

Onion powder freshly prepared at this laboratory was employed for E.R.H. studies by the Wink's weight equilibrium method.[1] Nine lots of onion powder (5 g. each) were accurately weighed into 9 flat-bottomed metallic dishes and exposed to nine different relative humidities[2] ranging from 5 to 90% at 25-26° C. The gains or losses in weights of different lots of onion powder were determined after 1, 2, 4, 8 and 24 hours and followed up every 24 hours till the moisture equilibrium of the product was obtained at each relative humidity. The relationship between the equilibrium moisture content and the number of days the product took to reach equilibrium at a particular relative humidity at 25-26° C. is presented in Table I. The changes in the texture and general condition of onion powder (Table II) with particular reference to caking and colour during the course of the experiment were employed for determining the critical and danger points for onion powder. A sample was considered as *'caked'* if a sharp rap on a wooden surface failed to loosen the powder in the dish.

TABLE I

Relation between equilibrium moisture content, relative humidity and time for equilibrium in onion powder

Per cent. relative humidity	Equilibrium moisture content %	No. of days to reach equilibrium
5	6·44	3
10	8·62	5
15	9·54	5
20	11·18	5
30	14·19	6
40	17·42	8
50	21·58	8
70	33·30	13
90	Mould attack visible on the 8th day (Moisture—62·46%)	..

TABLE II

Effect of moisture level on the texture and general condition of onion powder

Moisture	Texture and general condition of onion powder
4·02	Free flowing
5·18	Tendency to granulation
6·44	Granulation
7·50	Slight caking
8·39	Caking
9·54	Slightly wet caking
11·18	Wet caking
14·19	More wet caking
17·42	Pasty consistency and slight darkening
21·58	Pasty and slight darkening
33·08	Very pasty, slightly darkened
62·46	Mould growth

Onion powder was found to be highly hygroscopic, picking up moisture even at 10% relative humidity, it being even more hygroscopic than garlic powder.[3] Further, unlike garlic powder,[3] mould attack was noticeable in onion powder stored at 90% R.H. (Table I). Based on the sorption isotherm (Fig. 1), for a typical onion powder (about 4% moisture), the equilibrium relative humidity would be somewhat less than 5%. To keep the powder free-flowing it is, therefore, essential to handle (detraying, milling and packaging) it in a room of low humidity (about 5%) which will avoid any material moisture uptake during handling. From caking view-point, the critical point for onion powder would be at 8·39% moisture level. For a typical free-flowing onion powder, the optimum moisture level would be about 4%.

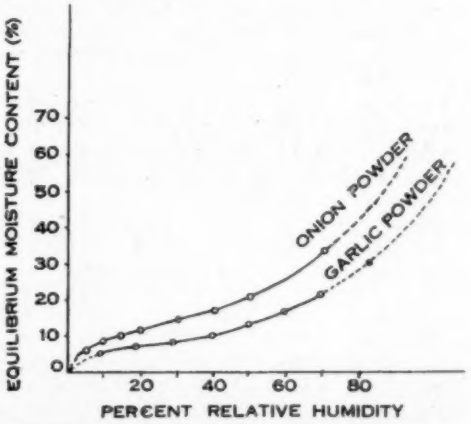


FIG. 1. Sorption isotherm or humidity moisture equilibrium curve for onion powder at 25–26° C.

While studying the effect of moisture level in onion powder on its colour, little difference was noticeable in the colour of samples up to 8·39% moisture (the critical point). Visible changes in colour were noticeable only after 15% moisture level, but they were still much less marked than those in the corresponding samples of garlic powder.[4] Further, greater browning was noticed during the storage of onion powder containing higher moisture content. It is, therefore, essential to reduce the moisture in onion powder to 4% or less wherein the colour and flavour changes were minimum.

Central Food Technological Research Institute, Mysore-2, *September* 17, 1959.

J. S. PRUTHI.
GIRDHARI LAL.

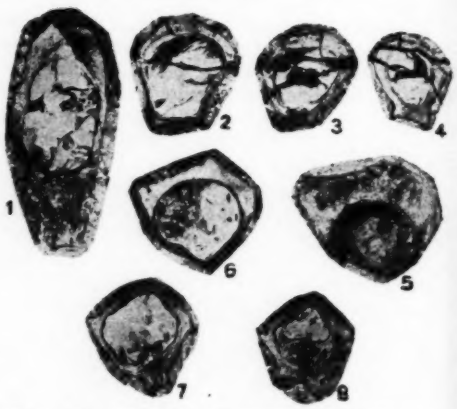
1. Wink, W. A., *Ind. Eng. Chem., Anal. Ed.*, 1946, **18**, 251.
2. Stokes, R. H. and Robinson, R. A., *Ind. Eng. Chem.*, 1947, **41**, 2013.
3. Pruthi, J. S., *et al.*, *J. Sci. Food. Agri.* (*U.K.*), 1959, **10** (7).
4. —, *Souvenir on Spices*, I.C.A.R., 1959 (In press).

ON TWO PALM FRUITS FROM THE DECCAN INTERTRAPPEAN BEDS OF MOHGAON KALAN

So far only a few palm fruits are known from the Tertiary formations of India. These are *Palmocarpon* (*Iriartites*) *takliensis* (Sahni, 1934), *P. bracteatum* (Sahni, 1934), *P. compressum* (Sahni and Rode, 1937), *P. insigne* (Mahabale, 1950), *P. mohgaœnse* (Prakash, 1954), *Tricoccites trigonum* (Sahni and Rode, 1937; Chitaley, 1956) and *Nipa hindi* (Sahni and Rode, 1937), all from the Deccan Intertrappean Series. Apart from this Kaul (1951) reported *Cocos sahnii* from Kapurdi, Rajasthan desert and Lakhanpal (1952) described *Nipa sahnii* from Garo Hills, Assam.

Recently two new palm fruits were collected by the author from Mohgaon Kalan, the well-known locality of the Deccan Intertrappean series of Madhya Pradesh. These are being reported in the present note.

One of them is a drupe of medium size, about 7·2 cm. long, 3·2 cm. broad and 3·1 cm. thick. It is more or less avate in shape with 4-6 longitudinal ridges (of which two are very prominent), on its surface (Figs. 2-4). The pericarp of the fruit is similar to that of a palm fruit. It is well developed both towards the apex and base of the fruit (Fig. 1) and made up of a thin epicarp, a semi-fibrous mesocarp and a hard endocarp. The epicarp is composed of thin-walled parenchymatous cells. The mesocarp is formed of loose, thin-walled cells of ground tissue with fibrous and fibrovascular bundles. A thin fibrous band runs all round the fruit just below the epicarp. Beneath this fibrous band the fibrous and fibrovascular bundles are more closely aggregated and in some regions they are arranged in 4-6 series. The endocarp is hard and formed of thick-walled cells with fairly small lumen. There is a well-developed seed inside the fruit, which measures 3·7 × 2·6 cm. (Figs. 1-3). However, an aborted carpel is also present towards the basal end on one side of the fruit (Figs. 3 and 4). Endosperm is tough and formed of thick-walled cells.



FIGS. 1–8. Figs. 1–4. *Patmocarpon indicum* sp. nov. Fig. 1. Median longitudinal section of the fruit showing a well-developed seed. Fig. 2. Cross-section of the fruit towards the epical end. Fig. 3. Cross-section of the fruit from the middle region showing a well-developed seed and an aborted carpel. Fig. 4. Another cross-section of the fruit from the basal end showing a well-developed seed and an aborted carpel. All natural size. Figs. 5–8. *Palmacarpon sulcatum* sp. nov. Fig. 5. Cross-section through the apical end of the fruit showing a well-developed seed. Fig. 6. Another cross-section towards the apical end of the fruit. Fig. 7. Cross-section towards the basal end of the fruit showing a grooved seed and two aborted carpels. Fig. 8. Cross-section towards the basal end of the fruit showing a grooved seed and three aborted carpels. All natural size.

The other palm fruit, which is also a drupe, is almost quadrangular throughout its length (Figs. 5-8) and measures about 5·75 cm. in length and 4·2 cm. in the broadest distal part. As a small piece towards the apical end of this specimen is not present, it is rather difficult to say anything about the presence or absence of an umbo. The pericarp is composed of a membranous epicarp, a semi-fibrous mesocarp and a hard endocarp. The mesocarp, which forms most of the pericarp, is composed of a tissue of

thin-walled cells with fibrous and fibrovascular bundles. Beneath the epicarp, there appears to be a thin zone of fibrous cells all round the fruit. The endocarp is composed of thick-walled cells. There is a well-developed seed inside the fruit (Figs. 5-7) which is roughly spherical measuring 2·8-3 cm. in diameter. Here the seed is distinctly grooved (Figs. 7 and 8) with the endocarp ridge dipping into it very similar to that of modern *Nipa fruiticans*. The sulcus (Figs. 7 and 8) is about 1·3 cm. broad but does not extend up to the apex of the seed. In addition to a well-developed seed, there are three aborted carpels towards the basal end on one side of the seed (Figs. 7 and 8). The endocarp is hard formed of thick-walled cells.

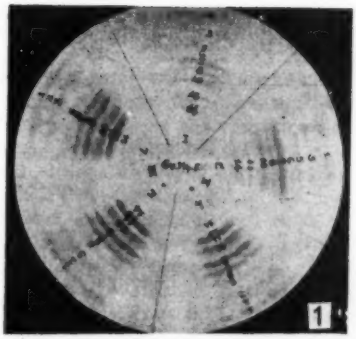
The whole organisation of this fossil fruit is similar to palm fruit. But at the same time its near resemblance with the fruit *Nipa* cannot be overlooked. Especially the characters like the almost quadrangular shape throughout its length with the ridges on its surface and the presence of a grooved seed with the endocarp ridge projecting into it can very well be compared with similar characters in the fruit of *Nipa*. However, pending the discovery of more and complete material, I have for the present included this fruit under the form genus *Palmocarpon*, and named the first fruit as *Palmocarpon indicum* and the second as *sulcatum* because of the presence of a sulcus.

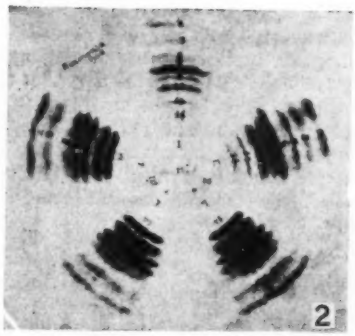
Birbal Sahni Institute of Palæobotany, U. PRAKASH.
Lucknow, *September* 21, 1959.

1. Chitaley, S. D., *The Palæobotanist*, 1956, **5** (2), 56-63.
2. Kaul K. N., *Curr. Sci.*, 1951, **20**, 138.
3. Lakhanpal, R. N., *The Palæobotanist*, 1952, **1**, 289-94.
4. Mahabale, T. S., *J. Indian Bot. Soc.*, 1950, **29** (1), 1-46.
5. Prakash, U., *The Palæobotanist*, 1954, **3**, 91-96.
6. Sahni, B., *Proc. 21st Indian Sci. Cong., Bombay*, 1934, 317-18.
7. — and Rode, K. P., *Proc. Nat. Acad. Sci. India*, 1937, **7** (3), 165-74.

A METHOD FOR A PERMANENT RECORD OF CHROMATOGRAM

IN view of the difficulty in preserving permanently the chromatograms of amino-acids, it has become necessary to have a permanent record of such chromatograms, before the colour of the bands fades away. Though photography is the usual method for recording, nowadays it has become very costly. Hence an attempt has been made to replace photography





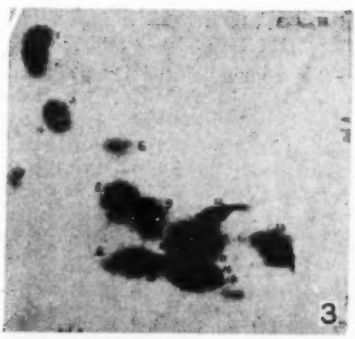


FIG. 1. Original chromatogram using Butanol : Acetic Acid : Water (4 : 1 : 1).

FIG. 2. Ammonia print of the chromatogram of Fig. 1

FIG. 3. Ammonia print of two-dimensional chromatogram using sol. A—Butanol : Acetic Acid : Water (4 : 1 : 1) and sol. B—Phenol saturated with buffer ; spot 7—proline

by ammonia printing or dry printing method which is economical as well as very simple in its technique.

The chromatograms after development with ninhydrin are kept over the ammonia process paper and both together are placed over a glass plate, with the chromatogram facing against the glass surface. Then they are tightly fitted into a frame and exposed to solar light, the time of exposure being fixed depending on the intensity of solar light and intensity of the bands. Immediately after exposure the ammonia process paper is placed in a chamber full of ammonia vapour. In about 10 to 15 minutes the dry printing paper is ready. It will be an exact duplicate of the chromatogram except for the colour. Here all the bands are blue in colour on a white background.

The advantages of this method are: (i) it gives an exact replica of the chromatogram in its original size; (ii) it gives a greater intensity of the colour of the band (Figs. 2 and 3) on a white bakground and (iii) a more interesting point is that proline which cannot be photographed (in black and white) can be recorded by this process (Fig. 2, band 6; and Fig. 3, spot 7).

French Institute, S. IDELMAN.
Pondicherry, B. SESHADRI.
September 29, 1959.

INVESTIGATION OF AMINO-ACIDS IN THE BERRIES OF *WITHANIA SOMNIFERA* DUNAL

DURING the course of an investigation[1] on the phytochemistry of *Withania somnifera* Dunal, it was observed that the fruits of this plant contained a high proportion of free amino-acids as evidenced by a strongly positive ninhydrin colour reaction. Therefore, an investigation was undertaken to establish the identity of the amino-acids present therein.

TABLE I

Amino-acids identified by the first wash liquid

R_f found	R_f reported	Colour with ninhydrin	Probable amino-acid
0·925	0·920	Yellow	Proline
0·810	0·800	Purple	Valine
0·650	0·640	do.	Tyrosine or alanine
0·520	0·500	do.	Asparagine or glycine

One gram of the dried berries was macerated with 2 ml. of 80% ethanol for one hour and 50 λ of the clear filtered solution was subjected to paper chromatographic separation. The method of circular paper chromatography of Oreskes and Saifer[2] was employed. The first wash liquid used was composed of phenol : isopropyl alcohol : water, in the proportion of 70 : 5 : 25. The data are recorded in Table I.

The second solvent system was composed of butanol : acetic acid : water in the proportion of 40 : 10 : 50 and the R_f values obtained are recorded in Table II.

TABLE II

Amino-acids identified by the second wash liquid

R_f found	R_f reported	Colour with ninhydrin	Probable amino-acid
0·710	0·710	Purple	Valine
0·470	0·450	do.	Tyrosine
0·450	0·440	Yellow	Proline
0·410	0·400	Purple	Alanine
0·320	0·310	Brown	Glycine

In order to further confirm the above findings, another solvent system was used as final check. This wash liquid was composed of methyl ethyl kytone : propionic acid : water in the proportion of 75 : 25 : 30. With this system the R_f values varied considerably yet the order of migration of the various amino-acids remained the same. Using known amino-acids for comparison, the presence of valine, tyrosine, proline, alanine and glycine was confirmed.

Similar spots could also be detected in the fresh berries of the plant indicating that these amino-acids are present as such in the plant and are not formed by enzymatic hydrolysis during the drying process. The significance of the occurrence of large amounts of free amino-acids may be explained by the fact that the proteolytic enzyme chymase is present in the berries of this plant.

Department of Pharmacy, C. K. ATAL.
Panjab University, A. E. SCHWARTING.
Chandigarh, and
School of Pharmacy,
University of Connecticut, U.S.A.,
August 14, 1959.

1. Atal, C. K., *Doctoral Thesis* submitted to the University of Connecticut, 1957.
2. Oreskes, I. and Saifer, A., *Anal. Chem.*, 1955, **27**, 854.
3. —, *Ibid.*, 1956, **28**, 501.

A NOTE ON THE OVULE DEVELOPMENT IN CARPELLOID STAMENS OF A *NICOTIANA* HYBRID

SEVERAL cases of staminal teratology are known in the genus *Nicotiana* but only two instances of carpellody of stamens appear to have so far been studied and described. Avery (1929) refers to a case of pistillody of stamens in *N. alata* and more recently Bhat and Krishnamurty (1956) have described the fasciated carpelloid stamens of *megalosiphon glauca* hybrids. Unlike the superficial modifications, these sex reversals are attributed to operation of recessive factors. The following note gives yet another instance, a carpelloid stamen mutation, observed in a three species hybrid of *Nicotiana* last year. It is proposed to bring out some of the interesting details relating to stages in the morphology and embryology of the modified stamens.

Only one out of many plants grown from the crossed seeds of (*N. glutinosa-N. trigonophylla*) × *N. megalosiphon* revealed the mutation. The modification of the stamen was uniform throughout the plant. The chromosome number of the hybrid was found to be 44 which was normally expected (*N. glutinosa*, $n = 12$, *N. trigonophylla*, $n = 12$, and *N. megalosiphon*, $n = 20$). The transformation was similar to the one described for *megalosiphon glauca* hybrid, namely, fasciation and shortening of stamens with ovules developing nakedly in pouches. The anther character was completely lost (Figs. 1-3).

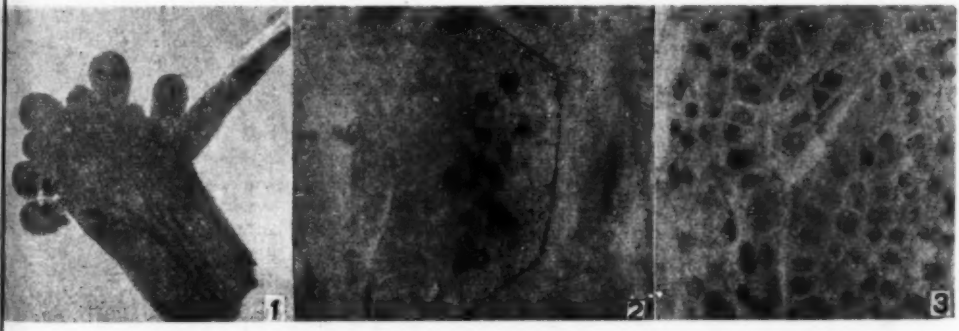
From the morphological view-point, it would be interesting to note that the modified stamens assumed a height similar to that of the ovary so that the ovules on the stamens came to occupy a position in level with those in the ovary. Perhaps, if the central ovary is removed and the five stamens are united edgewise, a closed carpel can be imagined with ovules parietally placented. Besides, the stamens have separated completely from the petals from which they usually arise epipetalous. It may mean that the carpelloid stamens have an origin closer to the ovary, and farther from the petals. Nectary has been found at the base of these structures which further substantiates their homology with the ovary.

A detailed study of the embryological stages of the ovule in the ovary as well as of those borne on the stamens was made and the following details were recorded as significant.

1. There is a marked coincidence in regard to *time*, *period* and *stage* of development of the embryo that develops in the ovary and that appearing on the stamen although they have differentiated independently. It is clearly evident that factors responsible for the differentiation and growth of these ovules are acting simultaneously.

2. Cellular size, nature and number are identical in both the types of ovules. At the end, however, the stamen borne ovules overgrow in size as compared to the normal ovules and this perhaps is due to lack of competition in the former, only a few ovules being borne on the modified stamen.

3. Stages in megasporogenesis follow same pattern in both the types of ovules. The archesporium is laid down at the same time and reduction division takes place simultaneously in both the ovules. Meiosis is irregular due to the complex nature of the genotypes (three unrelated species together) (Fig. 2). The



FIGS. 1–3. Fig. 1. Modified stamen of the trispecific hybrid *glutinosa—trigonophylla—megalosiphon* showing ovules. Fig. 2. Meiosis in the megaspore mother cell of the stamen borne ovule. Fig. 3. Degeneration of tetrads in stamen borne ovules.

chromosomes, mostly univalents, lie scattered, while only a few bivalents appear in some of the cells, the mean frequency being 3. The tetrad, however, is formed in most of the cells but all the four cells degenerate simultaneously (Fig. 3), and consequently no embryo is formed. The ovary also therefore has become sterile and fertilisation had to be ruled out.

4. The ovules on the stamens develop in a manner similar to the ovules in an ovary, in spite of the former being naked, a condition characteristic of gymnosperms only.

From the observations recorded, it is evident that the modification of the stamen is not superficial but under the control of factor or factors related to sex. Storey (1953) suggested the operation of two sets of factors modifying sex expression in papaya, one bringing about seasonal shifts from one sex to another, and the other causing stamens to become carpelloid. In the case described here, the seasonal factors have to be ruled out since the change was observed under normal climatic conditions. It is quite probable that the second set of factors might be operating to bring about carpellody. Since such a factor is suggested to be inherent in the genotype and expressing its potentiality under physiological changes, it is quite likely that the potential is in the genome of *N. megalosiphon* (as evidenced by its similar occurrence in another hybrid—*megalosiphon* × *glauca*) and that it is expressing not under a physiological stimulus but due to its location in a complex hybrid, *viz.*, *N. glutinosa*—*N. trigonophylla*—*N. megalosiphon*.

The authors wish to express their thanks to Dr. G. S. Murthy, Director, Tobacco Research, who has given them all encouragement for work and for kindly going through the manuscript.

Central Tobacco Research Institute, Rajahmundry, *September* 26, 1959.

K. V. Krishnamurty.
K. Appa Rao.

1. Avery, P., *Univ. Calif. Pub. Bot.*, 1929, **11** (15), 265.
2. Bhat, N. R. and Krishnamurty, K. V., *Sci. and Cult.*, 1956, **21**, 746.
3. Storey, W. G., *Jour. Heredity*, 1953, **44**, 70.

ABNORMAL OCCURRENCE OF A YELLOW FLEDGLING IN THE DESERT LOCUST

Normally immature adults of the desert locust, *Schistocerca gregaria* Forsk., exhibit cream, pink, brown, or grey coloration whereas yellow colour is found in the advanced instar hoppers or sexually mature adults. The writers, however, noticed that one adult (with crumpled wings), which fledged on 16th February 1959, had light yellow background colour. It was found amongst specimens bred crowded at the Field Station for Investigations on Locusts, Bikaner. The pronotal pattern resembled a fifth instar hopper. The precise colour of the yellowish adult and one of its companions (which did not exhibit any yellow colouration) is described in Table I according to the *Munsell Book of Colour* (1929-42) wherein the colour is expressed in numerical symbols.

Table I

Particulars	Adult with yellowish background colour		Adult without yellowish background colour	
General background ..	22·5	7·5/8	18·5	7/6
Hind tibia ..	25·0	8/9	15·0	7/6
Frons ..	20·0	7/7	15·0	7/6
Markings on pronotum ..	17·5	6/3	17·5	4·5/3
Markings on hind femur ..	17·5	4·5/3	17·5	4·5/3
Markings on frons ..	No markings		17·5	4·5/3
Elytral maculæ ..	17·5	6/3	17·5	4·5/3

Field Station for Investigations on Locusts, Bikaner, *July* 29, 1959.

D. R. Bhatia.
Kartar Singh.

1. *Munsell Book of Colour* (Pocket Edition), Baltimore, Munsell Color Company, Inc., 1929-42.

ON THE OCCURRENCE OF AN ADULT AMPHISTOME IN SHEEP LUNG

The apical lobe of the right lung in a sheep carcass, available at a slaughter-house, showed an areca-nut-sized cyst of a bluish-red colour with a yellowish-red area arround it. The cyst was hard to touch and its cavity was found to be full of a greyish-yellow, cheesy material of a semifluid consistency. A lightly pinkish but a somewhat opaque object came out of this mass and when it was pressed between a microslide and a coverslip it yielded an amphistome with a thin transparent covering all round it. The specimen, alive, mature with a large number of eggs in its uterus, was identified as a species of the genus *Cotylophoron* Stiles and Goldberger (1910) and had the following measurements :—Length, 5·3 mm.; maximum width (testicular zone), 2·2 mm.; oral sucker 0·48 × 0·36 mm.; œsophagus, 0·71 mm.; position of intestinal bifurcation from anterior end 1·2 mm.; distance of common genital pore from

anterior end, 1·59 mm.; genital sucker, 0·11 × 0·09 mm.; acetabulum, 0·71 × 0·67 mm.; anterior testis, 0·75 × 0·94 mm.; posterior testis, 0·86 × 0·71 mm.; ovary, 0·28 × 0·18 mm.; egg, 0·11 × 0·07 mm.

Species of *Cotylophoron* and some other amphistome genera, which are of world-wide occurrence in the rumen of ruminants, are considered innocuous in their adult stages but their immature forms are of great pathogenic importance causing paramphistomiasis (Pittoo or Gillar) and this disease may frequently affect severely the young stock, resulting at times in a high mortality in cases of heavy infestations. Borey (1959), in his studies on intestinal amphistomosis in cattle, reports that in sections of duodenum the young flukes were found to have reached the mascularis mucosæ as well. This behaviour can well explain the presence of the fluke in the lung—a case of erraticism, on the ground that the immature flukes reach other organs as well through the portal and hepatic circulation. One such form, on reaching the lung, could develop normally but, consequent upon the surrounding tissue reacting to its presence, the characteristic cyst formation may have resulted.

The present finding of an adult specimen of *Cotylophoron* sp. in the lung tissue of sheep is the second occurrence of a fluke in atypical focus in ruminants from this country, the first being that recorded by Srivastava (1939) who reported *Fasciola gigantica* (Cobbold, 1885) from the lungs of goats from the then North-West Frontier Provinces of India. There is also the report from Turkey of Can and Tamer (1953) of post-mortem findings of *Fasciola gigantica* in pulmonary lesions in epizootics of this liver-fluke.

Thanks are due to Dr. B. P. Pande, Professor of Parasitology at this College, for his guidance and going through the manuscript.

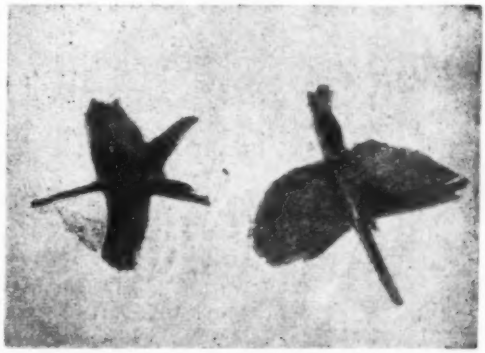
Department of Parasitology, S. M. Sood.
U.P. College of Veterinary Science
and Animal Husbandry,
Mathura, *August* 31, 1959.

1. Borey, J. C., *Australian Vet. J.*, 1952, **35** (6), 282–87.
2. Can, E. and Tamer, Y., *Turk. Vet. Hekimler Dernegi* 1953, **23** (78/79), 671–75. *vide Helminth. Abst.*, **22**, 689 *a*.
3. Srivastava, H. D., *Ind. J. Vet. Sci.*, 1939, **9**, 223–24.

4-WINGED FRUIT OF *TERMINALIA CRENULATA* ROTH.

Cooke in his *Flora of the Presidency of Bombay* described this tree under *Terminalia tomentosa*. Locally known as *Sajad*, these large deciduous trees which are fairly common in the forest at Pavagadh Hill, 29 miles NE. of Baroda (Bombay State), afford a valuable timber and are next to Teak in this district. For a complete description and synonymy of the Bombay plant *see* Santapau in *Jour. Bombay Nat. Hist. Soc.*, 1951, **50**, 305–06.

Writers of our popular floras, who mention the fruits of this plant, state that they are 5-winged. The fruits are normally 5-winged, as indicated even by the synonym *Pentaptera crenulata* and on numerous occasions we have noted it to be so. However, on 23rd April 1959, we found many 4-winged fruits. This has not been recorded in our floras. The 4 cm. long fruit is glabrous, about 4 cm. diam. including the 4 thin wings; venation of the wings includes numerous faint nerves which run horizontally from the axis to the edges.



5-winged 4-winged

FIG. 1. Fruits of *Terminalia crenulata* Roth.

The fruits are properly preserved and kept in the Herbarium of the Department of Botany, M. S. University of Baroda.

We are grateful to Rev. Father H. Santapau, S.J., St. Xavier's College, Bombay-1, for making many helpful suggestions in the preparation of this note.

Department of Botany, V. G. Phatak.
M. S. University of Baroda, G. M. Oza.
Baroda, *August* 10, 1959.

OCCURRENCE OF *RAUWOLFIA CANESCENS* LINN. IN GANJAM DISTRICT

Rauwolfia canescens Linn. has drawn much attention as a drug resource in our country. It has been found that the active principles in

this species are of greater percentage than that obtained in *Rauwolfia serpentina* Benth. which had been held in great esteem hitherto as a medicinal plant. Also the possibility of extraction of the requisite alkaloids from even the vegetative parts as the leaves in *Rauwolfia canescens* Linn., has added much interest to the species, thus indicating a more advantageous position than in *Rauwolfia serpentina* Benth. wherein the root alone has been the source and the commercial exploitation of which rendered to a great extent the depletion of plants that bore them.

Rauwolfia canescens Linn.

While studying the herbarium at the Industrial Section, Indian Museum, the author came across collections of *Rauwolfia canescens* Linn., by I. H. Burkill, Lieut.-Col. D. St. J. Grant and Edmund Candler, from Parlakimedi in the South Ganjam, although there has been no report of their collections in any of the published records. The author has also come across *Rauwolfia canescens* Linn., in many situations in the Ganjam District particularly in the vicinity of Parlakimedi.

In this note this species is reported from the Ganjam District also as it is hoped that the area and extent of its distribution would be helpful for possible commercial exploitation or extensive cultivation.

The author gratefully acknowledges the help and encouragement given by Sri. K. S. Srinivasan, Curator, and thanks the Principal of the Parlakimedi College, and Sri P. S. Rao who sent us some collections of *Rauwolfia canescens* Linn., at our instance.

Industrial Section, G. V. Subba Rao
Indian Museum,
Calcutta-13,
September 28, 1959.

SMUT ON ONION AND GARLIC IN MYSORE

Smut on onion (*Allium cepa* L.) and on garlic (*Allium sativum* L.) caused by *Urocystis cepulæ* Frost. was observed for the first time in Mysore in a field near Melur in Sidlaghatta taluk in Kolar district. The disease was observed in July 1958 on young seedlings of about a month old on the local variety of onion known as Chickballapur variety and in August 1959 in the same field on onion and garlic. The latter crop had been grown along the border of the main crop of onion.

Urocystis cepulæ occurs on several species of *Allium*. Liro[3] detected a specimen of *Urocystis cepulæ* in Persoon's herbarium in Holland. Anderson[1] thought that the disease originated in America from some wild species of *Allium* and then migrated to the cultivated forms. He found by sowing seeds of 18 species of *Allium* in heavily infested soil with *Urocystis cepulæ* that 16 species, *Allium cepa*, *Allium porrum*, *Allium fistulosum* (Welsh onion), *Allium nutans* and *Allium libani* are very susceptible to infection while *Allium nigrum*, *Allium obliquum*, *Allium ampeloprasum* and *Allium Hookeri* are fairly susceptible and that *Allium polyphyllum*, *Allium scoradoprasum*, *Allium sibiricum*, *Allium volhymicum*, *Allium fallex*, *Allium daravasicum* and winter beck onion are resistant but not immune. He reports that onion cultivated from bulblets remain completely free from smut. Gonzalez Fragosa[2] found *Urocystis cepulæ* both on onion and garlic (*Allium sativum* L.) among other smuts of Spanish flora deposited in the National Museum of Natural Sciences

FIGS. 1–…
…lic plant
…fection wi…
…g. 4. Mi…
…rmination

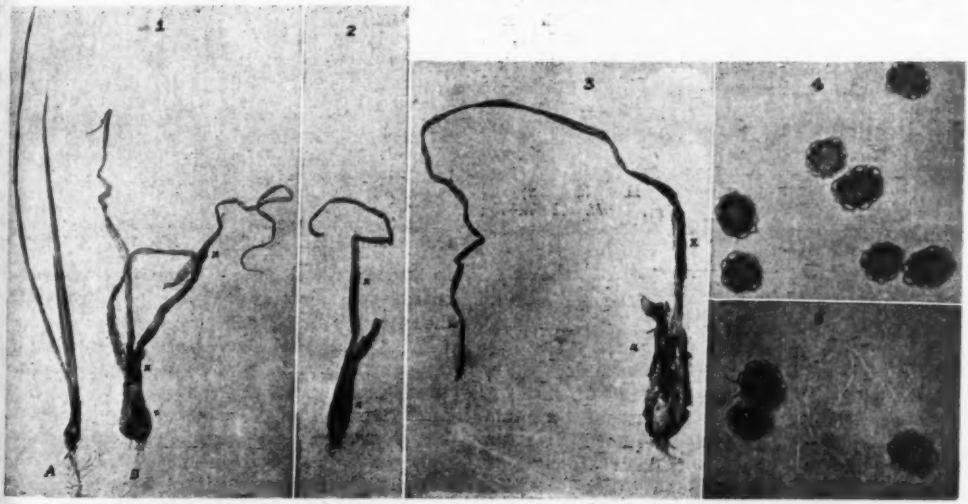
Madrid. Szembel[8] reports its occurrence on wild onion (*Allium sabulosum*) growing in sand-dunes on the Caspian Sea coast in Russia. Lapprometoff[9] found it on wild garlic (*Allium* sp.) during his systematic investigation of the fungal flora of Russian Central Asia. Savulesen[6] found it on Chives (*Allium schœnoprasum*) in Romania. Nagorny[5] records its occurrence on onion and Leeks (*Allium porrum*) in the Caucasus.

Mundkur and Thirumalachar[4] record *Urocystis magica* on the leaves of *Allium rubellum* M. Bieb ; collected from Rawalpindi by Stewart and on leaves of *Allium sphærocephalum* L. from Quetta by Ginai. These specimens are from Pakistan. There is no record of *Urocystis cepulæ* on onion and garlic in India. Its occurrence on these two hosts in Mysore is the first report in this sub-continent.

The disease was observed in a sporadic form on the young seedlings. It was confined to a small patch in a single field. The stand of both the onion and garlic crops in the infected field was very thin. The plants remain stunted in growth, do not develop bulbs, become weakened and die.

Dark elongated, thickened, raised sori appear on the scales and leaves. These later on extend to the entire leaf as a dark lesion (Figs. 1 B, 2 & 3). On older plants the typical smut lesions are conspicuous as raised blisters on the scales of the bulbs and at the basal portions of the leaves. In severe cases of infection the leaves curve downwards and begin to dry up (Fig. 3). The sori burst open by the rupture of the epidermal layer and expose the black powdery mass of spores. The spore balls (Fig. 4) are dark coloured, ovoid to spherical and measure 12·4–24·8 μ (average 17·8 μ) in diameter. The sterile appendage spores numbering as many as 17 (average 10) are small, thin-walled, lightly tinted, spherical and attached to the central fertile cell. They measure 1·8–8·8 μ (average 4·5 μ) in diameter. The fertile spore is brownish in colour, spherical, single, rarely 2 in a ball, thick-walled and measure 10·6–18·6 μ (average 13·4 μ) in diameter. These dimensions of the spores compare favourably with those recorded for *Urocystis cepulæ* (Spore balls 17–25 μ, sterile spores 4–8 μ and fertile spores 12–16 μ) by Stevens.[7]

The spores do not readily germinate in tap water, distilled water, soil water or in water to which onion tissue is added. They germinate slowly in 48-72 hours in rain-water and in sugar solution. The spore on germination gives rise to a characteristic short, hemispherical, hyaline basidium which produces a number of



FIGS. 1–5. Fig. 1. (A) Healthy onion plant. (B) Infected onion plant with smut sori (*x*). Fig. 2. Infected garlic plant with smut sori (*x*) on the scales and on the leaf. Fig. 3. Onion plant in an advanced stage of smut infection with the characteristic bending of the leaf and the ruptured sori (*x*) on the leaf and on the scales of the bulb. Fig. 4. Microphotograph of smut spore balls, × 1,100. Fig. 5. Microphotograph of the fertile spore showing the germination with the hemispherical basidium producing hyphal branches, × 1,000.

short hyphal branches which develop into a mycelium (Fig. 5).

Specimens have been deposited at the Indian Agricultural Research Institute, New Delhi, and at the Commonwealth Mycological Institute, Kew, England.

The origin of the disease is under investigation.

The author is grateful to Dr. Ainsworth of the Commonwealth Mycological Institute, Kew, for confirming the above finding.

Divn. of Plant Pathology, N. S. VENKATAKRISHNIAH.
Dept. of Agriculture,
Bangalore, *August* 5, 1959.

1. Anderson, P. J., *Abst. Phytopathology*, **1924, 14, 26.**
2. Corzalez Fragosa R., *Bol. R. Soc. Esp. Hist. Nat.*, 1924 **24** (3), 116–27; *Abst. Rev. App. Myc.*, 1924, **3,** 610.
3. Liro, I., Finland, *The Onion Smut. Internat. Bull. of Plant Protect.*, 1934 **8** (7), 150–51 ; *Abst. Rev. App. Myc.*, 1924, **13,** 743.
4. Mundkur, B. B. and Thirumalachar, M. J., *Ustilaginales of India*, The Commonwealth Mycological Institute, Kew, Surrey, 1952, pp. 83.
5. Nagorny, P. I., *Scientific Papers, Applied Sections of Tiflis. Bot. Garu.*, 1929, **6,** 104-04 (German Summary) ; *Abst. Rev App. Myc.*, 1929, **8,** 813.
6. Savulesen, T , *Ann. Inst. Recherches Agron. de Roumanie*, 1930. **1,** 214–66 (Rumanian with French Translation) ; *Abst. Rev App Myc.*, 1925, **10,** 77.
7. Stevens, F. L., *Plant Disease Fungi*, The MacMillan Co., New York.
8. Szembel, S. J , *La Defense des Plantes, Leningrad*, ii 1926 **7,** 524–30 ; *Abst. Rev. App. Myc.*, 1926, **5,** 646.
9. Zaprometoff, N. G., "Materials for the mycoflora of Central Asia, Part 2. Uzbe istan Exper.," *Plant. Prot. Stat. Tashkent. Publ.* 11, iii–70 ; *Abst. Rev. App. Myc.*, 1928, **8,** 339.

ACCESSORY CHROMOSOMES IN *PENNISETUM TYPHOIDES*

So far as known to the writer there was no previous record of occurrence of accessory chromosomes in the genus *Pennisetum*. Recently the writer obtained seed of *Pennisetum typhoides* under the name "Dochan" from Sudan, for cytological study. In twety-five root-tips examined cytologically accessory chromosomes varying in number from 1-3 in addition to the normal complement of $2n = 14$ were noted in twenty-four root-tips. Plants were raised from the seed in the experimental farm of the Botany Department and from this population five plants out of six examined, revealed the presence of B-chromosomes in the pollen mother cells. Externally there are no differences between the plants with B-chromosomes and plants without them.

At mitotic metaphase these accessory chromosomes have a length of about half of the shortest pair of the complement and usually lie at the periphery of the metaphase plate (Fig. 1).

FIGS. 1–3

Fig. 1. Mitotic Metaphase showing 2 B-chromosomes peripherally situated.

Fig 2. Paired B-chromosomes at Pachytene.

Fig. 3. Metaphase I, 3 B-chromosomes are associated to form a trivalent. All figures, × 1,250.

In the pollen mother cells three accessory chromosomes were noted in all the plants and these form associations giving rise to trivalents (Fig. 3). At pachytene these B-chromosomes are characterised by the presence of heterochromatic accumulation at one end and the centromere is sub-terminal. Following the heterochromatic region in the long arm, which present eight chromomeres distributed along the whole length of the arm (Fig. 2). The accessories at pachytene stage are about half of the shortest chromosome of the complement which happens to be nucleolar one. There was no pairing between the B-chromosomes and A chromosomes of the complement.

The Diakinesis and Metaphase I association of these B-chromosomes along with pachytene associations are given in Table I.

TABLE I

Association of B-chromosomes from Pachytene to Metaphase I

	1_{III}	$1_{II}+1_{I}$	3_{I}	Total cells
Pachytene ..	19	12	1	32
Diakinesis ..	53	21	7	81
Metaphase I ..	28	11	1	40

At anaphase I the chromosomes are usually distributed 2-1 and occasionally the univalent may divide during anaphase I and then 3-1 or 2-2 distribution may be observed. At anaphase II when 2 B-chromosomes are present these divide and are distributed 2-2 and when there is 1 B, this may divide to give 1-1 distribution. Thus, there are two types of microspores, one type with 2 B's and the other with only one. The pollen fertility is quite normal, about 97% of pollen being good.

There are certain problems connected with the origin of *P. typhoides* particularly about the centre or centres of origin and the polyphyletic nature of its origin. Previously on grounds of taxonomy and concentration of varieties several authors like Hackel, Stapf, Leek, Werth (*cf.* Krishnaswamy, 1937 and 1951)[1,2] and Vavilov[3] expressed the opinion that the primary centre of origin for this species is Africa particularly the region of Sudan and Abyssinia. Of all the varieties so far examined by the author B-chromosomes are found in plants raised from the seeds of Sudanese origin. The B-chromosomes according to Muntzing (1954 and 1958)[4,5] give some indication as to the centre of origin, as he observed that these accessory chromosomes are more frequent in primitive strains than in highbred commercial varieties. Thus the present cytological evidence points to Sudan-Abyssinian origin of this cultivated plant, a conclusion also arrived at by others (Hackel, Stapf, Leek and Vavilov) on other grounds as mentioned above.

I wish to express my sincere thanks to Prof. J. Venkateswarulu for helpful suggestions and to the Chief Agronomist, Ministry of Agriculture, Government of Sudan, for kindly supplying the seed. This work was carried out during the tenure of a Government of India Research Scholarship.

Department of Botany, Andhra University, Waltair, *July* 29, 1959.

J. V. PANTULU.

1. Krishnaswamy, N., *Curr. Sci.*, 1937, **6**, 355.
2. —, *Ind. Jour. Gen. and Pl. Breed.*, 1951, **11** (1), 57–74.
3. Vavilov, N. I., *Chronica Botanica*, 1949–50, **13**, 1–6.
4. Muntzing, A., *Caryologia* (suppl. to), 1954, **6**, 282–301.
5. —, *Trans. of the Bose Research Inst.*, 1958, **21**, 1–15.

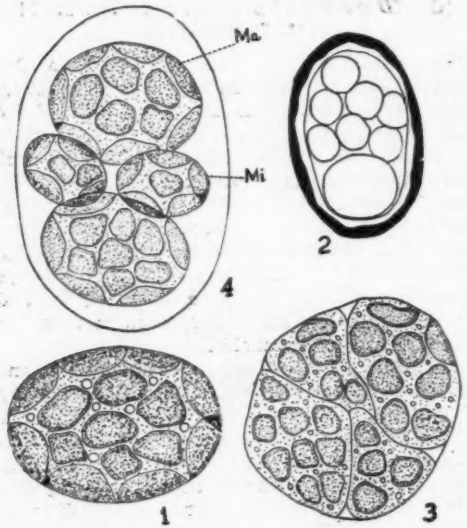
A NEW SPECIES OF *OOCYSTIS* (*O. KUMAONENSIS* SP. NOV.) FROM NAINI TAL

DURING his study of the algal flora of Naini Tal District, the author came across an interesting form of *Oocystis*. This alga was collected by the writer in August, 1958 from a dripping rock in the campus of the college. Subsequently it was collected from five more places in the vicinity of Naini Tal. It was found growing in mucilaginous masses mixed with *Cosmarium* and some colonial blue-green algæ. The alga was collected periodically and was always examined in living condition. Iodine in KI and iron-alum-hæmatoxylin were used to ascertain the presence of pyrenoids.

Vegetative cells always occur singly and measure 31·2-35·1 μ in length and 19·5-23·4 μ in width. The cells are usually ellipsoidal (Fig. 1) with broadly rounded poles. The cell-wall is smooth and thin in younger cells (Fig. 1), but appreciably thickened in older resting cells (Fig. 2). Each cell contains several discoidal chloroplasts (Fig. 1) with a small pyrenoid in each.

Reproduction usually occurs by means of autospores. Four autospores are regularly formed in each cell. The formation of the autospores in the present alga is rather interesting and is, therefore, described in some detail below. During reproduction the vegetative cell, which is destined to form the autospores, gets slightly enlarged and becomes irregular in shape (Fig. 3). The protoplast undergoes two successive divisions by bipartition and this results in the formation of four unequal daughter protoplasts (Fig. 3). These daughter protoplasts which are generally found cruciately arranged, are eventually metamorphosed into autospores (Fig. 4). Of these four autospores, two are big and two small and have been designated as macro- and micro-autospores respectively. Macro-autospores (Fig. 4 *Ma*) are about three

times bigger than micro-autospores (Fig. 4 *Mi*), and measure 23·4-27·3 μ long and 15·6-19·5 μ broad, while micro-autospores are 8·5-14·6 μ long and 6·8-9·7 μ broad. The autospores, when fully formed, are liberated by the gelatinization of the parent cell-wall. The macro-autospores after their liberation from the parent cell wall enlarge somewhat and behave just like the parent cell in producing four autospores of two different sizes. The exact fate of the micro-autospores is not yet clearly understood, but the presence of large number of small yellow cells in the sample with degenerating protoplast indicates that probably they degenerate.



FIGS. 1–4. *Oocystis komaonensis* sp. nov. Fig. 1. A young vegetative cell, showing discoidal chloroplasts. Fig. 2. An older resting cell with thick cell-wall. Fig. 3. Cell, showing the bipartition of the parent-protoplast into four unequal daughter protoplasts; Fig. 4. Cell, showing two macro-autospores (*Ma*) and two micro-autospores (*Mi*). (Figs. 1–4, × 500.)

Examination of the literature (Lemmermann, Brunnthaler and Pascher, 1915; Fritsch, 1935; Smith, 1951, among others) has revealed no described species of *Oocystis* with attributes entirely like those described above. The alga has been described as a new species and is called *Oocystis kumaonensis* sp. nov.

Oocystis kumaonensis sp. nov.—Cells solitary, broadly ellipsoidal with rounded poles, 31·2-35·1 μ long and 19·5-23·4 μ broad; cell-wall thin and smooth in younger cells, appreciably thickened in older resting cells; chloroplasts parietal, discoidal, with pyrenoids; reproduction by four cruciately arranged autospores, two big (macro-autospores) and two small (micro-autospores); macro-autospores three times bigger than micro-autospores; macro-autospores 23·4-27·3 μ long and 15·6-19·5 μ broad, micro-autospores 8·5-14· μ long and 6·8-9·7 μ broad liberation of autospores by gelatinization of the parent cell-wall.

Habitat.—From a dipping rock in the premises of D.S.B. Government College, Naini Tal.

Culture number.—KPS-2.

The author is grateful to Prof. M. O. P. Iyengar for his kindness in examining the sample of *Oocystis kumaonensis* sp. nov. and communicating his valuable suggestions.

Department of Botany, K. P. SINGH.
Th. D.S.B. Government College,
Naini Tal (India),
August 31, 1959.

1. Fritsch, F. E., *The Structure and Reproduction of the Algæ*, University Press, Cambridge, 1935, 1.
2. Lemmarmann, E., Brunthalar, J. and Pascher, A., "Tetrasporales, Protococcales, EinzelligeGattungen unsichler Stellung" In Pascher's, *Die Süsswasser flora Deutschlands, Österreichs und der Schweiz*, 5, *Chlorophyceæ* 2, Jena, 1915.
3. Smith, G. M., *Freshwater Algæ of the United States*, McGraw-Hill Book Company, New York, 1951.

SOME OBSERVATIONS ON VEGETATIVE PROPAGATION OF *ZIZIPHUS MAURITIANA*, LAM. (*BER*) FROM GOOTEES AND CUTTINGS WITH THE AID OF GROWTH REGULATORS

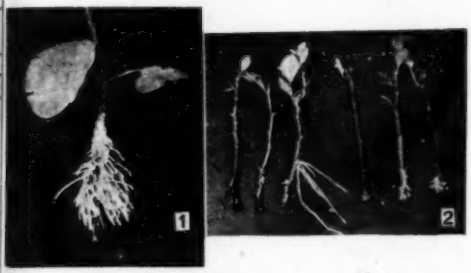
Ber is commonly propagated by seed. Ring and shield budding are the only methods of its vegetative propagation practised at present. So far, no effort has been made to study the ability of growth regulators on rooting the air-layers and cuttings of this useful fruit plant. A trial was, therefore, laid out to find out the possibilities of propagating *Ber* (*Ziziphus mauritiana*, Lam.) by gootee and cutting.

One to two years old shoots (on 12-15 years old trees) were treated with 10,000 p.p.m. each mixture of indole butyric acid and alpha-naphthalene acetic acid in lanolin paste. Treated gootees were covered with wet sphagnum moss and tied firmly with plastic wrappers.

Ringed (shoots on which about ½" ring of bark was removed a fortnight earlier) and unringed cuttings approximately 9" in length with 5 to 7 buds and two leaves at the apex were prepared. Basal ends of these cutting

were dipped in 200 and 400 p.p.m. concentrations of alpha-naphthalene acetic acid for 24 hours, washed with water and planted in pots containing coarse sand.

Air-layers (5) examined two weeks after treatment demonstrated profuse root development with an average of 86 roots per gootee (Fig. 1). The longest root measured 4·8 cm. Control had no roots.



FIGS. 1–2

Fig. 1. Two weeks old Air-layer of *Ziziphus mauritiana*, Lam. treated with 10,000 p.p.m. each mixture of indole butyric acid and alpha-naphthalene acetic acid.

Fig. 2. Three weeks old cuttings of *Ber*.
A—Alpha-naphthalene acetic acid, 400 p.p.m.
B—Ringed cuttings treated with NAA, 200 p.p.m.

Cuttings (5 from each treatment) observed three weeks after planting showed excellent root initiation. Unringed cuttings, treated with 400 p.p.m. NAA alone, recorded 100% rooting with an average of 16 roots per cutting. Length of the longest root in this treatment was 12·1 cm. (Fig. 2 A).

Vigorous root formation was also achieved in all the treatments with ringed cuttings, except control. NAA, 200 p.p.m. produced 22 roots per cutting on the average (Fig. 2 B).

Govt. Agricultural College, Kanpur, *August* 19, 1959. O. S. JAGHARI.

OCCURRENCE OF *HETEROSPORIUM* BLIGHT OF ONIONS IN INDIA

During June 1957 a severe blight of leaf and seed stems of onions (*Allium cepa* L.) caused by *Heterosporium Alli-Cepæ* Ranojevic was observed in an experimental plot at the Provincial Agricultural Research Farm, Shalimar, Srinagar. The disease was very conspicuous on some Panjab types obtained for experimental purpose, though it was also evident on other varieties grown for seed production. *Heterosporium* on onions has not hitherto been recorded from India but has been reported from Norway, Serbia, France and Britain.[1]

The fungus was found attacking the leaves and the seed stems of the autumn sown onions grown for seed production. The spots appear first as small white elliptical depressed areas on the leaves and seed stalks. Later on they enlarge to form distinct greyish-white elliptical areas up to 3·5 cm. long and 2 cm. broad. The fructifications of the fungus appear as minute black dots in the centre of the lesions which later on turn into a dark-green mat. In badly affected plants spots coalesce and diseased parts wither.

The causal fungus has yellow-brown septate mycelium which ramifies through the host tissue. The conidiophores (Fig. 1, *Cp*) grew out

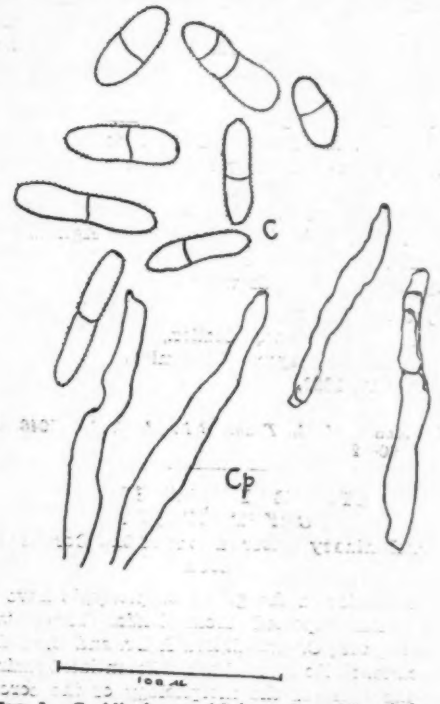


FIG. 1. Conidiophores (*Cp*) and conidia (*C*) of *Heterosporium Alli-Cepæ* Ranojevic.

in clusters. They are yellow-brown, simple, septate, knotty and concolorous with the conidia, and are highly variable in size being 40-180 μ long and 8-16 μ broad. The conidia (Fig. 1, C) are yellow-brown with verrucose walls, 1-2 septate, straight, cylindrical or more usually constricted at the septa ; rarely either one-celled, pear-shaped or three-septate. They are borne successively singly at the new growing tips of the conidiophores and are 30-80 μ long and

10-20 μ broad. Growing tips of the conidiophores have got pores and a number of such pores are visible due to their lateral growth. Preliminary germination studies revealed that fresh spores germinate readily in sterile distilled water at 27° C. after 4 hours.

This disease has been reported from very few localities. Moore[1] while discussing about the occurrence of this disease in Britain and other places suggested *Heterosporium Allii* var *Cepivorum* Nicholas and Aggery as the proper name for this fungus. The Kashmir material, however, was examined by Dr. M. B. Ellis of Commonwealth Mycological Institute, Kew, and identified as *Heterosporium Allii-Cepæ* Ranojevic. Since the disease appears on seed onion crop, it might become a limiting factor in the production of onion seeds in the state. Further studies on the perpetuation of the disease are in progress.

The author is grateful to Dr. Ellis for identification of the fungus and also to Mr. W. C. Moore, Plant Pathology Laboratory, Harpenden, Herts, Britain, for sending reprints and some information on this disease. Thanks are also due to Mr. G. M. Butt, Director of Agriculture, Jammu and Kashmir Government, for providing facilities for this work.

Mycology Section, T. N. KAUL.
Agricultural Research Station,
Lalmandi, Srinagar (Kashmir),
August 13, 1959.

1. Moore, W. C., *Trans. Brit. Mycol. Soc.*, 1946, **29**, 90–92.

STUDIES IN THE GENUS *CRYPTOSTEGIA*

Preliminary Observations of the Corolline Corona

Two species of the genus *Cryptostegia* have so far been reported from India. These two species, *viz.*, *C. grandiflora* R. Br. and *C. madagascariensis* Boj. have been differentiated mainly on the basis of the morphology of the corona lobes. Critical observations indicated that the variability of this character was of considerable extent. The authors, therefore, have undertaken a detailed study of the genus with a view to ascertaining the correct basis of differentiating the two species.

The corona lobe types observed during the study are shown in the accompanying figure. These types can be grouped under three categories.

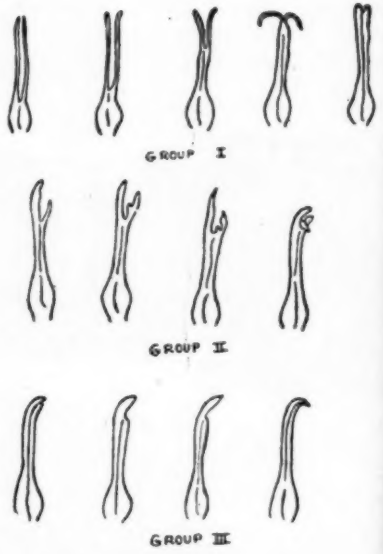


FIG. 1. Showing the variations in the coronal structure in the genus *Cryptostegia* (Chavan, Sabnis and Pathak).

Group I—The corona lobes are divided into two long, filiform segments which show various degrees of fusion.

Group II—The corona lobes are divided into two segments which are unequal and which show protuberances.

Group III—The corona lobes are entire with incurved tips.

Further studies are in progress and the results will be reported in due course.

Department of Botany, A. R. CHAVAN
M. S. University of Baroda, S. D. SABNIS
Baroda, *September* 14, 1959. C. H. PATHAK

1. Chavan, A. R. and Sabnis, S. D., "Record of *Cryptostegia madagascariensis* Boj. from Baroda", MSS. (unpublished), 1959.
2. Santapau, H. and Irani, N. A., "*Cryptostegia madagascariensis* Boj., a new record for Bombay", *Jour. Bom. Nat. Hist. Soc.*, 1958, **55** (3), 594.

REVIEWS

ntroduction to the Physics of Many-Body Systems. By D. Ter Haar. (Interscience Publishers, Inc., New York), 1958. Pp. viii + 125. Price $ 1.95.

In this tract, the author has attempted to ve a survey of the several topics falling under e problem of many-body systems, such as the artree-Fock Approximation for many electron stems, collective motion of electrons in metals, und waves in solids and the many nucleon oblems. The book is divided into two parts. Part I, the author first gives a review of the artree-Fock equations for a system containing any electrons, then discusses the method for taining the charge density for electrons in oms, which was developed by Thomas and rmi, and finally gives a cursory survey of e application that the Hartree-Fock method s found in nuclear physics, namely, Brueckr's theory of many nucleon systems.

Part II deals with the various theories given Tomonaga, Pines and others to describe the llective behaviour of electrons in solids. The cent development of Plasma oscillations in etals is expounded in one chapter. Besides, ere is a chapter on liquid helium in which e various theories proposed to explain the perfluidity of helium have been outlined.

A vast amount of literature has grown around ch one of the topics dealt with in this book, d the author's intention of bringing them all a single small tract as this under the comn title of 'Many-Body Systems' is therefore lly ambitious and leaves him with no choice discussing the subjects in detail. A general der of physics as distinct from a specialist ll however find the book enjoyable and a rce of knowledge of the many facets of the blem of many-body systems.

V.

---

ements of Wave Mechanics. By N. F. Mott. (Cambridge University Press), 1958. Pp. 349. Price 15 *sh.* net.

The present volume is a revised edition of e author's *An Outline of Wave Mechanics* hich was published by the Cambridge Univerty Press in 1930. The book has been written r students in the final year of an honours rse in experimental physics. The exposition lucid and enables the student to have a sound sp of the physical principles and to get an insight into the abstract mathematical formalism of quantum mechanics.

Though the book has been called a student's edition, the price of 15 *sh.* seems to be still high.

Aircraft Electrical Engineering. (Chapman & Hall Ltd., 37, Essex Street, W.C. 2), 1959. Pp. 349. 50 *sh.* net.

This book is the fourth in the series of textbooks published under the authority of the Royal Aeronautical Society. The earlier volumes on *Aircraft Hydraulics* and *Landing Gear Design* have set a very high standard and it is gratifying to see that the same quality is maintained in the present volume too.

The complexity of modern aircraft has been responsible for the very elaborate equipment needed for its safe operation. With the achievement of supersonic flight under extreme conditions of atmospheric temperature and pressure, technical demand for perfection of equipment has been most exacting and a considerable amount of fundamental and applied research has been devoted to the solution of the problems arising from these new developments. Electrical engineering applications to aircraft now cover a very wide field as a result of recent advances in aeronautics. An indication of this is provided by the number of specialists contributing to this volume, each aspect being dealt with by an expert with many years of experience.

The first chapter gives an introductory survey of the field with special reference to altitude effects, influence of design characteristics such as weight, vibration and reliability, current aircraft electrical systems and generation of electrical power in aircraft. In the subsequent chapters there is a discussion of the environmental conditions and functional requirements and the problems that are met with such as brush wear at high altitudes, vibration and cooling. The design details of DC machines, AC machines and electrical switch gear are described in considerable detail in relation to basic design criteria. The chapter on aircraft batteries discussess the properties of various types now in use and their behaviour under different conditions. The author who is a member of the Royal Aircraft Establishment concludes that the zinc-silver oxide battery shows most promise for aircraft purposes; but it would require further study and development for achieving

the best method of its use. According to him lead-acid and nickel-cadmium batteries have both potentialities for future development and will continue to be used for many years more.

Various electrical power systems are discussed in a separate chapter. The relative advantages and disadvantages of AC and DC systems are indicated. The main disadvantage of the AC could be obviated by using a constant frequency system. But so far this has not yet been achieved to any large extent. But new developments in future show promise of achieving constant speed drives and these are finding increasing application in the United Kingdom and the United States of America. But an AC system would still require DC for certain specific applications and hence a mixed system would offer the best solution. The constant frequency AC system would offer a very promising field of future development particularly for high altitude aircraft operation.

The last chapter deals with future trends and has therefore special significance. Reliability and the effects of temperature and altitude would be major considerations. The power requirements for large aircraft in future may be as high as 700 kVA and such power must perforce be generated at higher voltages than the conventional 28 volt system. As already mentioned, constant frequency AC offers great possibilities, although many difficulties have yet to be overcome. Electricity is also being increasingly used in servo mechanisms and an important application in future would be in power-operated flying controls.

The book would be of great value to designers particularly since the majority of the contributors are members of the Aircraft Industry having a first-hand knowledge of the day-to-day problems and, therefore, the opinions expressed by them have the authority of actual experience. It goes without saying that this book should be an indispensable addition to the technical libraries of establishments and factories engaged on research, design, development, manufacture, installation and operation of aircraft electrical equipment and systems.

P. N.

The Genetic Basis of Selection. By Micheal Lerner. (John Wiley, New York; Chapman & Hall, London; India: Asia Publishing House, Bombay), 1959. Pp. xvi + 298.

Animals and plants are being methodically selected all over the world. This book is by a poultry breeder, and almost all his detailed examples are taken from poultry breeding. Because the author knows just what he is talking about, he has written a very good book. It is full of statistics, but the statistics are for use rather than ornament, and a biologist with no training in statistics should be able to follow a great deal of it, since graphs are used as far as possible.

I fear that most breeders, both of animals and plants, in India are still at the stage of improving a breed by breeding from its best members. They will find much to cheer them in the history of the Berkeley flock of White Leghorn poultry, whose average egg production up to October 1st, when they were about 18 months old, rose from 126 in 1933 to 225 in 1948. But in 1953 it was only 219, probably as a result of disease. The breeding of poultry for egg production, like that of cattle for milk production, involves the choice of males based on the performance of their female relatives. This is not a simple matter.

However, more than half the poultry now bred in the United States are now cross-bred, that is to say, derived from mating two inbred lines. These lines must be selected, not for their egg production, but for their "combining ability", that is to say, capacity for producing hybrids with a high egg yield. Clearly such selection is a far more complicated affair than simple selection. I do not suppose that any such selection is yet being practised in India on animals, though a little is being done on maize, and I hope on jowar.

I should be able to recommend the book unreservedly but for two facts. The binding is bad. Two pages in the copy sent to me for review are stuck together, others partially so. Secondly, I have failed completely to discover its price. The price may not matter in the U.S.A. It matters a lot in India.

J. B. S. HALDANE.

A History of Embryology. By Joseph Needham. Revised with the assistance of Arthur Hughes. (Cambridge University Press), 1959. Pp. 303. Price 52 *sh.* 6 *d.*

The second revised edition of this well-known classic needs no introduction. The history of embryology has a fascination of its own. "The history of Science is not a mere succession of inexplicable geniuses, direct Promethean ambassadors to man from heaven" (p. 15). "The mistakes of our predecessors remind us that we may be mistaken; their wisdom prevents us from assuming that wisdom was born with us; and by studying the processes of the

he thought, we may hope to have a better understanding, and hence a better organisation of our own" (p. 11).

Dr. Needham traces the development of material and mental techniques, how the mental audacity of Aristotle led to stagnation for centuries, the gradual weaning of embryology from issues associated with ethics and theology and emphasizes the need for "speculative thought, accurate observation and controlled experiment". The story unfortunately ends at 1800.

The reflections of the author or the situation existing today are thought-provoking. Researches on morphological, physiological and chemical embryology has led to the accumulation of a vast amount of knowledge. But as yet there has emerged no unifying hypothesis linking this wealth of facts. According to the author the doctrine of axial gradients, field theories and speculations on genetic control of enzymes do not fill this lacuna. The urgent need, therefore, appears to be advances of a theoretical nature to explain the tissue interaction during normal development which remains still a riddle.

M. K. SUBRAMANIAM.

Biogeography and Ecology in Australia. Edited by A. Keast, R. L. Crocker and C. S. Christian. *Monographiæ Biologicæ*. Vol. VII (Uitgeverij Dr. W. Junk—Den Haag), 1959. Pp. 640. Price 65 Dutch Guilders.

Australia was discovered in 1606. For close on a hundred and eighty years afterwards it remained uncolonized. The first steps of exploration occurred during about 50 years from 1788 and then came great pastoral expansion and the gold rush. And it is only during the past thirty years that science and industry have developed in the continent. This development, however, has been phenomenal. The uniqueness of the environment in Australia as well as its natural history have provided such unrivalled opportunities for the preservation and development of certain peculiarities in its faunal distribution, that the continent could be regarded as one of Nature's great ecological laboratories. Any chapter in this faunal history would be fascinating and all are covered in the volume under review, which sets forth the past, the present and the future of Australian Natural History. From marsupial to man, Australian faunal peculiarities have been dealt with in special reference to their physical and biological environments.

Prof. F. S. Bodenheimer has written the first chapter of this book setting forth the salient features of Australian fauna and flora. For those who believe that the continent does not offer anything more than uninteresting, arid and desert conditions, Dr. Keast's survey of its physiography comes as a stimulating surprise. Two chapters on human ecology by Tindale and Taylor follow, one dealing with primitive aboriginal man and the other with the more recent human response. The rest of the book deals with different aspects of Australian flora and fauna, their ecology, adaptive radiations and distribution. Understandably, certain peculiar features of Australian biology get special treatment, like the Marsupialia, for example. Here is contained one of the fullest and most comprehensive treatments of marsupial ecology, adaptations and reproduction. So do the freshwater fishes, and among plants, the Eucalyptus, and the more recent problem of the Rabbit in Australia. Nor are the interesting agricultural problems of the continent neglected. The problems of soil erosion, of semi-arid ecology, biological control of harmful plants and animals,—all these are treated by experts in the respective fields. The famed Merino sheep gets special treatment too,—its cultivation, climate, and its parasites.

It is doubtful if a treatment of this kind is available for any other land mass in the world. The fact that it is relatively small and insular, and its biological history is recent, has been of immense help in this co-ordinated study. The C.S.I.R.O under whose auspices and sponsorship the volume has been prepared could be justly proud of it.

B. R. S.

Axenic Culture of Invertebrate Metazoa : A Goal. Editor-in-Chief : Otto v. St. Whitelock. (*Annals of New York Academy of Sciences*, 77), 1959. Pp. 25-406. Price $ 4.50.

Germfree Vertebrates : Present Status. Editor in chief : Otto v. St. Whitelock. (*Annals of New York Academy of Sciences*, 78), 1959. Pp. 1-400. Price $ 5.00.

There has been a concerted measure to study growth of life under absolutely sterile conditions. With reference to invertebrate metazoa, axenic culture or rearing of individuals of a species on nonliving medium is not so easy as that of Protists. The axenic study was initiated by a Russian and is now followed up in at least three countries including Japan. The problem becomes really a taxing one when one wants to eradicate the number of symbionts living in the

test animal, especially the bacterial flora in certain parts of the vertebrate body. Remarkably, members of higher taxa like Annelida, Echinoderma and Protochordata have not been studied from the view-point of gnotobiosis. One of the aims of this study is to get to know the minimal nutritional requirements of the metazoa which may serve as a tool in medicine and agriculture. Culturing and rearing marine animals under laboratory conditions is a feat which, however, has been achieved in some cases. Marine polychætes have been reared in the laboratory through several generations. Providing the axenic fauna with sterile food is probably the most difficult aspect of this study. The invertebrate section under review is divided into five parts and there are 24 learned contributions.

It is common knowledge that germ-free life is only possible under experimental conditions. One has to provide the subject with pure air, pure food and pure water. One could visualise the immense technical skill required in maintaining vertebrates in absolutely sterile medium and feeding them with sterile food. At the Lobund Institute, Indiana, germ-free monkey, rat, rabbit, hamster, mouse and chicken have been maintained and of these rat, mouse and chicken have bred through successive generations. So far fish, amphibia and reptiles have not been studied.

In experimental biology germ-free animals are being greatly used and they are now obtainable commercially. Divided into five parts, there are 28 fascinating papers dealing with instrumentation characteristics of germ-free animals and the possible lines of future research in the part dealing with vertebrates.

L. S. R.

The Ashoka Guide. [Published by the Educational Trade Builders Association, Ambala, Cantt. (India)], Price Rs. 18·50.

This voluminous compilation which must have involved much efforts is devoted to giving useful and essential information regarding Scientific and Educational Trades in India. At the present time when there is great expansion going on in the field of manufacture of scientific apparatuses and instruments in the country, a Guide of this type will be very valuable. *The Ashoka Guide* consists in the main of two parts: (1) a paginated part of 360 pages which forms the chief feature of the book and gives addresses, running literally to thousands of manufacturers, importers and retailers dealing in scientific goods and educational materials, and (2) an unpaginated part of more than 250 pages of illustrated advertisements from hundreds of leading manufacturers and suppliers in these trades. The main part is divided into eighteen sections according to the classification of goods and in each section the addresses are given in the alphabetical order of the towns where the trade is located.

Schools, Colleges, Scientific Institutions, Research Centres and Small-scale manufacturers will welcome the Guide as they will know exactly where to get what. The Guide will enable the consumer to directly contact the trade and thus will be of benefit to both. The volume is printed on art paper, the printing is bold and clear, the binding is delux with heavy cardboard. These features commend the book not only to institutions and trades but also to the advertisers.

Books Received

The Cathode Ray Tube and Its Applications. III Edition. By G. Parr and O. H. Davie. (Chapman & Hall, London W.C. 2; India: Asia Publishing House, Bombay-1), 1959. Pp. xii + 433. Price 50 *sh.*

Perfumes, Cosmetics and Soaps with Special Reference to Synthetics, Vol. I. By W. A. Poucher. (Chapman & Hall, London W.C. 2; India: Asia Publishing House, Bombay-1), 1959. Pp. xvi + 463. Price 75 *sh.*

Pure and Applied Physics, Vol. 3. Principles of *Quantum Electrodynamics* (Translated from German). By J. Bernstein Walter E. Thirring. (Academic Press Inc., New York-3; India: Asia Publishing House, Bombay 11), 1958. Pp. xv + 234. Price $ 8.00.

I.C.A.R. Monograph No. 27—Rice—Cultural Trials and Practices in India. By M. Subbiah Pillai. (Indian Council of Agricultural Research, Queen Victoria Road, New Delhi), 1959. Pp. ii + 166. Price Rs. 7·75.

Advances in Chemical Physics, Vol. II. Edited by I. Prigogine (Interscience Publishers, New York), 1959. Pp. ix + 412. Price $ 11.50.

General Cytochemical Methods, Vol. I. Edited by J. F. Danielli. (Academic Press Inc., New York-3), 1958. Pp. xi + 471. Price $ 12.80.

The Cytopathology of Virus Infection. By Robert Love and others. (*Annals of the New York Academy of Sciences,* New York, Vol. 18 Art. 1), 1959. Pp. 1-214. Price $ 4.50.

A Guide-Book to Biochemistry. By K. Harrison. (Cambridge University Press, London N.W. 1) 1959. Pp. vii + 149. Price 17*sh.* 6*d.*

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Sri. K. V. Narasimham for his thesis entitled "Spectroscopic Investigations on Some Uranyl Salts", and D.Sc. Degree in Geophysics to Sri. B. Subba Rao for his thesis entitled "Studies on some Hydro-Clymatic Aspects of India".

Gujarat University has awarded the Ph.D. Degree in Physics to Shri Duggal Shakti Prakash for his thesis entitled "A study of time variation of Cosmic Rays at low latitudes".

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board Fellowships for the year 1960 have been awarded to the following candidates : A. R. Sheth, Bombay ; K. C. Das, Calcutta ; G. V. G. Krishna Rao, Hyderabad ; P. J. Dave, Bombay ; B. N. Uma, Bangalore ; A. K. Deb, Bangalore ; T. N. Pattabhiraman, Vellore ; M. V. Venkatesha Murthy, Visakhapatnam.

Lady Tata Memorial Trust Scientific Research Scholarships

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1960-61 commencing from 1st July 1960. Applicants must be of Indian nationality and *Graduates in Medicine* or *Science* of a recognised University. The scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of a scientist of standing in a recognised research institute or laboratory on a subject of scientific investigation that must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must conform to the instructions drawn up by the Trust and should reach by March 15, 1960. Candidates can obtain these instructions and other information they desire from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

Natural Rubber Research Conference

An International Conference on Natural Rubber Research, sponsored by the Rubber Research Institute of Malaya with the support of the Government of the Federation of Malaya and the Rubber Producers' Council, will take place in Kuala Lumpur from Monday, 26th September to Saturday 1st October 1960. Those submitting papers will be asked to provide the title by 1st February ; an abstract of not more than 250 words by 1st April ; the completed manuscript, in doublespaced typescript, by 15th July. Correspondence should be addressed : Rubber Research Institute of Malaya (Rubber Conference), P.O. Box 150, Kuala Lumpur, Malaya.

Joint British Committee for Vacuum Science and Technology

Following the Institute of Physics London Conference on high vacua held in April last, various suggestions were made for arranging regular British meetings on vacuum science and technology, and for British participation in International Conferences in this field.

As a result of informal discussions between societies and institutes in this country a "Joint British Committee for Vacuum Science and Technology" has now been formed. The committee consists of representatives from ten bodies including The Institute of Biology, The Institutes of Chemical, Electrical and Mechanical Engineers, The Institute of Metals, The Institute of Petroleum, The Physical Society and The Institute of Physics.

Its objects are : (*a*) To co-ordinate and help to initiate meetings in the whole field of vacuum science and technology arranged by constituent bodies and (*b*) to act in the collective interest of the constituent bodies by maintaining liaison with the International Organization for Vacuum Science and Technology and with National Vacuum Societies, and otherwise.

The Institute of Physics has agreed to provide the secretariat for the joint committee ; communications should be addressed to the Secretary of the Joint British Committee at its headquarters, 47, Belgrave Square, S.W. 1.

Journal of Mathematical Analysis and Applications

The new journal published by the Academic Press Inc. will provide medium for the rapid publication of carefully selected mathematical papers treating classical analysis and its manifold applications. In recognition of the fact that other disciplines contribute new concepts and problems to the continuing growth of

mathematics, papers devoted to the mathematical treatment of questions arising in physics, chemistry, biology and engineering will be encouraged; in these papers the emphasis will be upon the analytical aspects and the novelty of problem and solution. One novel feature of the Journal will be that the refereeing system used in most journals is replaced by a Board of Associate Editors, each of whom may accept manuscripts, thus minimizing the delay between receipt and publication. (Subscription for Vol. 1, 1960, is $16·00).

Contemporary Physics (A Journal of Interpretation and Review)

Many of the developments in physics that have taken place within the past two or three decades have been so exciting, novel and intricate that it becomes very difficult for one who has not been closely following these developments to understand what really is modern physics. It is not uncommon to find in some universities chairs in modern physics being held by persons who in a sense have become prematurely "ancient". It is not their fault either. As Sir Cyril Hinshelwood points out "many aspects of the subject are of very great inherent difficulty. They are based upon unfamiliar conceptions, often developed by advanced mathematical reasoning and sometimes expressed in a complex and abstract, symbolism".

Hence a journal of the type "*Contemporary Physics*" established to publish articles by experts in the field, giving various aspects of physics in perspective in a scientific and at the same time an understandable way, will appeal to a large number of scientists engaged in different fields of activity.

The Journal is edited by G. R. Noakes and printed and published by Taylor and Francis Ltd., and will appear Six times a year. The subscription per volume (6 parts) is £ 1-7-0 ($ 4.00) post free. The first number, October 1959 (80 pages) contains the following major articles: Molecular Beams, by Prof. O. R. Frisch; Nuclear Structure, by Dr. R. J. Blin-Stoyle; Alexander von Humboldt and the Beginnings of Geophysical Research by Dr. C. Kellner.

Electron Emission from Silicon Carbide

Westinghouse Laboratories report an effect which has been recently discovered by which it is possible to obtain a constant flow of electrons directly out of the surface of certain semiconductor materials. The latest semiconductor to produce this electron emission is silicon carbide—a hard, crystalline solid best known for its widespread use in impure form, as an abrasive in grinding wheels. The density of the electron emission is found to be equal to that in the average electronic tube. The new effect envisages the possibility of electronic tubes of the future being "transistorized". Such a device would, in effect, combine into a single operating unit many of the inherent advantages of both semiconductors and vacuum tubes. It would result in what might be called a 'solid state' electronic tube.

New Hypothesis on Formation of Radio Galaxies

According to the Soviet astrophysicist Academician Ambartsumyan, the hypothesis that each radio galaxy represents a combination of two galaxies formed as a result of their accidental collision in space and ensuing reciprocal penetration is not correct. He points out that the powerful radio emission from these galaxies has been caused by the division of the nucleus into two parts rather than by the process of collision. It was discovered during observation of a huge number of accumulations of galaxies in the universe that each accumulation is formed by way of a single or repeated division of certain original formation rather than as a result of the clustering of a certain number of galaxies of independent origin. Ambartsumyan draws the conclusion that many accumulations of galaxies must in fact represent group of galaxies jointly formed in recent times and now moving apart. This conclusion has been corroborated in the past few months by American astronomers.

Distinction between Natural and Synthetic Diamonds

Tolansky and Sunagawa report in *Nature*, 1959, 184, 1526 the results of their investigations of the surface microstructures of fine natural diamonds and specimens of microdiamond made synthetically by the General Electric Company of Schenectady. The surface structures have been studied using both interferometry and phase-contrast microscopy methods. They find three new characteristics shown by the synthetic diamonds. (1) There are occasional cubic faces on the synthetic diamonds which have a highly perfect smooth optical finish. Such smooth perfection on cubic faces is quite unknown on natural diamonds, although such perfection has been found occasionally on one or two highly perfect natural octahedral faces. (2) Quite a number of synthetic diamonds reveal a new form modification. The

re typical dendrites. They most closely esemble in shape some germanium dendritic rystals. It will be recalled that the germanium rystal has the diamond structure. (3) The ost notable observation has been the discovery several spiral growths on quite a number f the good-quality cubic faces of the synthetics. number of spirals have been found on differnt crystals, and it would appear that most of hem favour originating near a corner of the ubic face. These observations lead to the conlusion that both the spirals and dendrites eported here are due to some special causes istinguishing the synthetic from the natural iamond. This may be either due to different onditions during formation, or alternatively may be due to metal carbide inclusion.

unnel Diode

The tunnelling effect in thin semiconductor unctions, first discovered in 1957 by Leo Esaki, young Japanese physicist, has recently been tilized in the development of the tunnel diode by the General Electric Co., U.S.A. The new evice has many advantages over the transistor nd may ultimately replace the transistor in any of its applications. Limited quantities are ow being made available to industry for exerimentation.

The tunnel diode gets its name from the uantum-mechanical tunnelling which characterzes its unique operation. In highly doped n junctions, the majority charge carriers can unnel through the junction and appear with the peed of light at the other side. The device hibits a voltage-controlled negative conductnce which makes it adaptable for many applitions, as an oscillator, amplifier, or switching lement, and has a predicted operating range igher than 10,000 Mc./s. At frequencies higher an 2,000 Mc./s. the device has already proved qual in performance to the best transistor vailable.

It will be seen that in the characteristic of n ordinary diode, the breakdown voltage creases as the impurity concentration is creased. When the impurity concentration creases to about 6×10^{19} atoms per c.c. (for ilicon), the semiconductor begins to resemble alloy and the characteristic is in the breakwn condition at zero and even slightly posive bias.

For all back biasing, the diode is highly conucting in the reverse direction; for small forard biasing, the current increases linearly with ltage in the forward direction until it reaches peak. With increased forward bias, the forward current then drops to a minimum, thereby manifesting the negative conductance peculiar to the tunnel diode. With still larger forward bias the characteristic increases like that of an ordinary diode.

The important criteria for making a tunnel diode are heavy doping in the order of 10^{20} atoms per c.c. (for silicon) and an extremely thin depletion region in the order of 100 angstroms.

The concept of amplification by the use of negative conductance is not new. In 1918, A. W. Hull disclosed the dynatron (a voltage controlled negative conductance device) and in 1935, E. W. Herold pointed out the possibility of using its unusual characteristic for amplification. However, the lack of a convenient device has made the use of such amplifiers unattractive. It now appears that the simple, inexpensive tunnel diode will reawaken interest in negative conductance amplifiers.

Tunnel diode amplifiers have gain-bandwidth products and noise factors considerably better than those of grid controlled electron tubes. One of the most impressive features is the wide temperature range over which the negative characteristic can be obtained—from 4·2° K. (liquid helium) to over 400° C. for silicon devices. Also, in a radioactive environment a conventional transistor is badly degraded because radiation shortens the life-time of the minority carriers; however, since tunnel diodes operate by the flow of majority carriers, they are particularly resistant to radiation effects. Many circuits have already been built with tunnel diodes including *i-f* amplifiers, oscillators, convertors, *r-f* detectors and various switching devices which respond to within a fraction of millimicrosecond and require very little power.—*Electronics*, 1959, **32**, 54.

Semiconductors of Organic Polymers

The Institute of Petrochemical Synthesis of the USSR Academy of Sciences has developed what may well be the first synthetic polymeric semiconductors. It was polyacrylonitril, the well-known wool substitute. Under the effect of ionising radiations it became electrically conductive like germanium and silicon. The radiation dose was 4·5 million roentgens. The material thus obtained has successfully passed tests at the Institute of Semiconductors. Another organic semiconductor is based on a combination of polyacrylonitril with siloxane. It is believed that polymeric semiconductors are more stable and can be processed more easily.

Such semiconductors can be synthesized out of natural gases and oil cracking products.

Topotactically Crystal-oriented Ferromagnetics

In recent years a group of compounds possessing hexagonal crystal structure has been added to the ceramic magnetic materials. They are compounds of Fe_2O_3 with BaO and MeO (Me represents one of the divalent metals Mn, Fe, Co, Ni, Zn or Mg). The individual crystals of many of these compounds exhibit marked anisotropy ; in some the magnetization shows a strong preference for orientation in the direction of the c-axis, in other compounds the preference is for an arbitrary direction perpendicular to the c-axis. In the first case the material is said to have a preferred *direction* of magnetization, in the second a preferred *plane*. Materials of the first kind are particularly suited for making permanent magnets (*e.g.*, ferroxdure $BaFe_{12}O_{19}$). Materials of the second kind are magnetically soft and particularly suitable for use at high frequencies up to about 1000 Mc/s.

To derive full benefit from the magnetic anisotropy it is desirable in both cases that the c-axes of the crystallites in the polycrystalline material, obtained by sintering, should all be parallel. Such a "crystal-oriented" material—which thus possesses a structure—shows the same magnetic anisotropy as its constituent crystallites ; the sintered non-oriented material, on the other hand, is isotropic. The method hitherto adopted to make these crystal-oriented materials is to mix a fine crystal powder of the material to be oriented in a liquid so as to form a thick suspension in which the crystals are easily able to rotate. To align crystals that have a preferred *direction*, the suspension is introduced into a static magnetic field ; for preferred-*plane* orientation a rotating field is used. The crystal orientation so obtained is made fast by compressing the suspension into a pellet of the desired form. Upon subsequent firing for a few hours at 1,100 to 1,300° C. the crystals become sintered together, in which process the orientation is preserved and sometimes even improved.

In a new method which has been evolved at the Philips Research Laboratories at Eindhoven, a pellet is pressed from a suspension consisti of a mixture of 1 mole $BaFe_{12}O_{19}$, 2 moles C and 2 moles Fe_2O_3 whilst a static magnetic fi is applied. This causes the alignment of t strongly anisotropic ferroxdure crystals, but n of the non-magnetic CoO and Fe_2O_3 crysta When the pellet is fired (not in a field) 1,250° C., chemical reaction takes place and sintered aggregate of hexagonal crystals of t compound $BaCo_2Fe_{16}O_{27}$ is formed. The impor ant thing is that the c-axes of these new cryst show the same orientation as the c-axes of t ferroxdure crystals which disappeared duri the reaction. We thus have the phenomen that in a chemical reaction between solids t crystal orientation of the reaction product correlated with that of one of the initial su stances. The term *topotaxy* has been used denote this phenomenon. The topotactic method is at present being employed in t laboratory for preparing new materials for u in microwave directional isolators.—*Philips Technical Review*, 1958/59, 20, 354.

Ion Thrust Device

An ion thrust device directed towards prototype engine configuration has been operation at Rocketdyne, a division of Nor American Aviation, Inc., for several month producing "quantitative" measurements of i thrust. The prototype ion unit operates in vacuum tank which simulates conditions outer space. Like the proposed flyable engi the experimental unit produces a stream charged particles similar to the stream electrons in a television tube. This curre provides the propulsive thrust.

A propellant, such as cæsium, is vaporiz and fed into an electrically charged chamb There an electron is removed from each at of vaporized propellant, leaving a positive i The ions are then pulled out of the chamb by a high voltage electrostatic field, accelerat to velocities up to 300,000 m.p.h., and higher necessary, and then discharged in a stre through the thrust chamber, thus providing propulsion—*J. Frank. Inst.*, 1959, 268, 423.

2-60. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

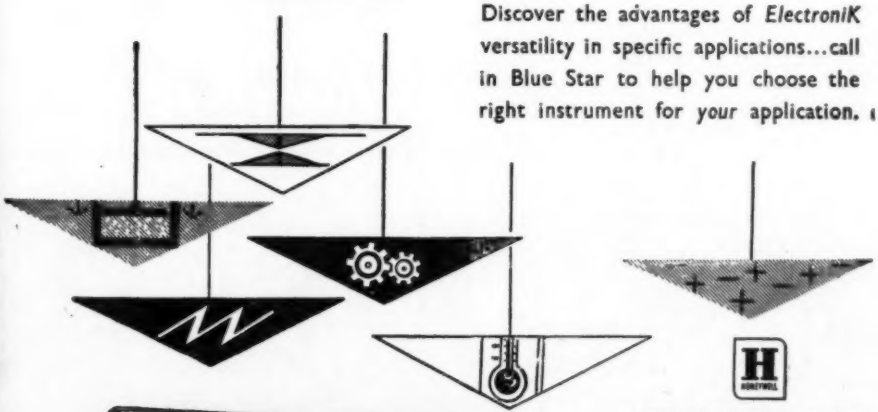
India : Rs. 12-00. Foreign : Rs. 16-00 ; £ 1-4-0 ; $ 4·00.

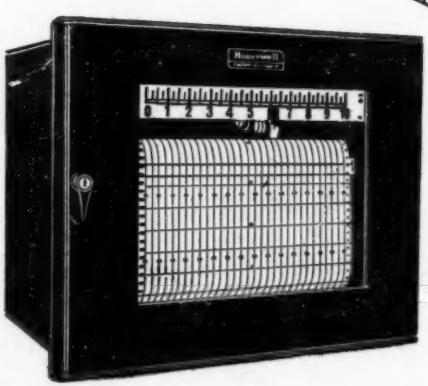
The *ElectroniK* recorder or indicator is a thousand instruments in one

An *ElectroniK* instrument adapts easily to your changing needs, never becomes obsolete. Its remarkable versatility is made possible by the many measuring circuits...many types of records or indications...many pen or print wheel speeds...and the wide variety of functions that can be incorporated in the instrument.

Use *ElectroniK* instruments to measure temperature, pressure, flow, pH, chemical concentration, voltage, speed —*any* variable that's translatable into a d-c signal.

Discover the advantages of *ElectroniK* versatility in specific applications...call in Blue Star to help you choose the right instrument for *your* application.





Honeywell

First in Control

Exclusive Distributors

BLUE STAR

BLUE STAR ENGINEERING CO. (Bombay) PRIVATE LTD.

KASTURI BUILDINGS
JAMSHEDJI TATA ROAD, BOMBAY 1

Also at CALCUTTA, DELHI, MADRAS

PSBS-97

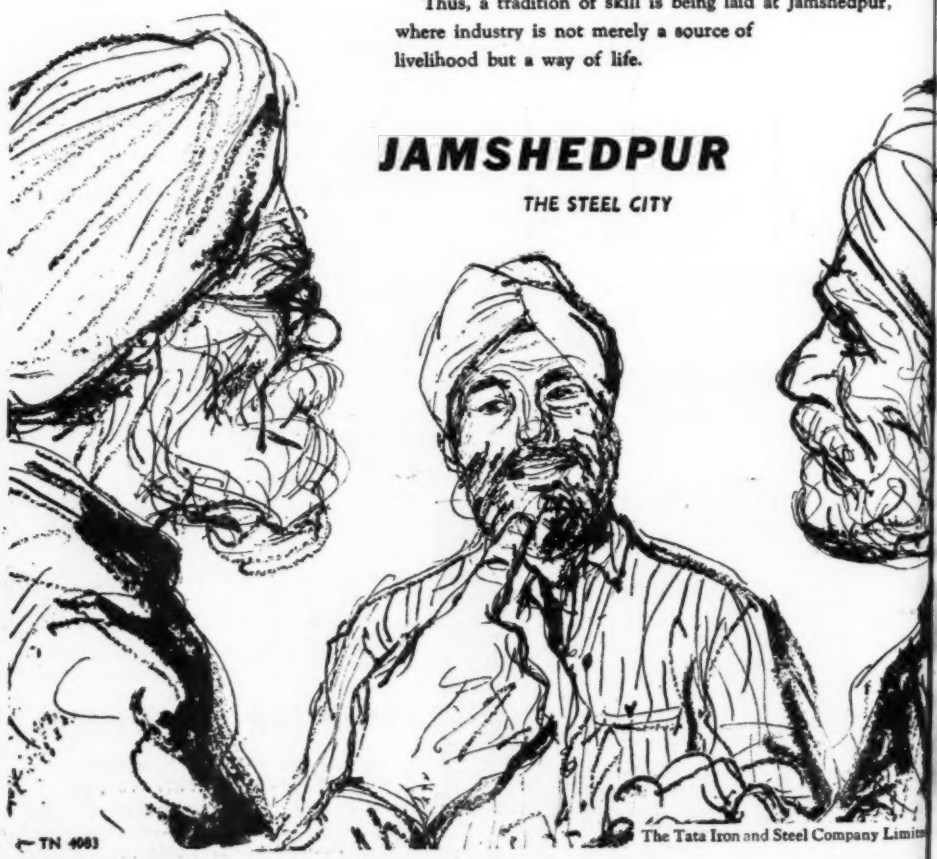
the beginning of a tradition

FIFTY YEARS AGO, Sardar Pratap Singh Bhumra, now 87, was assembling cranes and electrical equipment as India's first steel works was taking shape in the wilderness of Chhotanagpur.

His son, Jwala Singh, joined the steel works his father helped to build. Drawing upon his mature technical skill, he suggested an improvement to soaking pit cranes which won him a reward from Management and appreciation from the American manufacturers.

Hari Singh, Jwala Singh's son, imbibed the family tradition early in life. A young electrician in Tata Steel's Skelp Mill, he was recently sent to Japan to study advanced crane maintenance.

Thus, a tradition of skill is being laid at Jamshedpur, where industry is not merely a source of livelihood but a way of life.



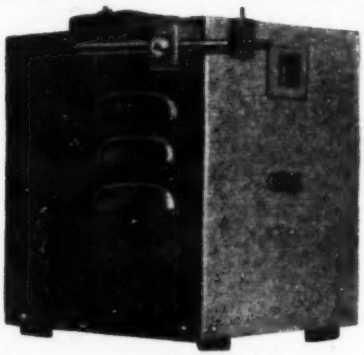
JAMSHEDPUR

THE STEEL CITY

TN 4083

The Tata Iron and Steel Company Limited

MELTING POINT APPARATUS: (for mixed melting point) Manufactured at our own Factory under Personal Supervision.



The apparatus is for use when the melting point of two specimens and their mixtures must be determined simultaneously. It consists of a rectangular aluminium block with a built-in electric heating element and Horizontal cavity in which three glass capillaries and a thermometer enter and are viewed through an adjustable lens, in front against a bright background formed by a ground glass screen illuminated by a lamp. The aluminium block is lagged and enclosed in a box which together with the lamp and lens carrier is mounted on a common base. The two specimens and their mixture are placed adjacent to each other in the three holes controlled by a switch. The apparatus is supplied without thermometer and capillaries. Total rating (heating and illumination) 135 watts at 230 volts AC.

CONTACT :

UNIQUE TRADING CORPORATION

221-SHERIFF DEVJI STREET

BOMBAY-3

GRAMS : "UNILAB" PHONE : 30011

TELE { PHONE: 35-2052, 35-4356 / GRAMS : "JABAKHARA"

Director-in-Charge

Dr. B. N. Dutta, M.Sc., D.Phil.

Support Govt. Import Policy by Using Oster's Products

- ACID SULPHURIC
- ACID HYDROCHLORIC
- ACID NITRIC
- AMMONIUM HYDROXIDE
- LABORATORY REAGENTS
- ANALYTICAL REAGENT ACIDS
- INDUSTRIAL CHEMICALS, Etc.

Oster Chemical & Pharmaceutical Works (Private) Ltd.

78 B, Manicktolla Street

CALCUTTA-6

ESTD. 1922

Telegrams : TEZABALAYA Telephone : 35-3147

We offer our services for G. R. quality acids with guaranteed test report as follows:—

Acid Sulphuric, A.R. S.G. 1·84	
Container	Resistant Glass
Non-Volatile matter	0·0025%
Nitrate	0·0003%
Chloride	0·0003%
Arsenic	0·00007%
Iron	0·0001%
Heavy Metal (as Pb)	0·0002%
Ammonium Hydroxide, A.R. S.G. 91–2	
Container	Resistant Glass
Non-Volatile matter	0·002%
Oxygen absorbed	0·0008%
Chloride	0·0001%
Sulphide	Passes Test
Sulphate	0·0003%
Carbonate	0·003%
Iron	0·00001%
Tarry matter	Passes Test
Arsenic	0·000005%
Heavy Metal (as Pb)	0·00002%

LUCKY ACID & CHEMICAL WORKS

32/2, Muraripukur Road, CALCUTTA-4

Sigcol

LABORATORY
GLASS APPARATUS

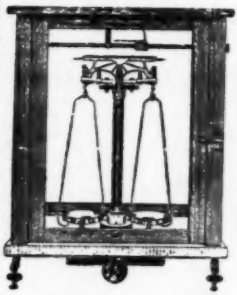
卐

Sole Selling Agents:

GHARPURE & CO.

P-36, ROYAL EXCHANGE PLACE EXTN.
CALCUTTA 1

Gram: "MEENAMO" Phone: 22-2061



KEROY
Short Beam
Analytical
Balance

No. K 1

Really Dependable Balance for Degree Classes and Research Laboratories

Sensitiveness .. 1/10th mg.
Capacity .. .. 200 gm.

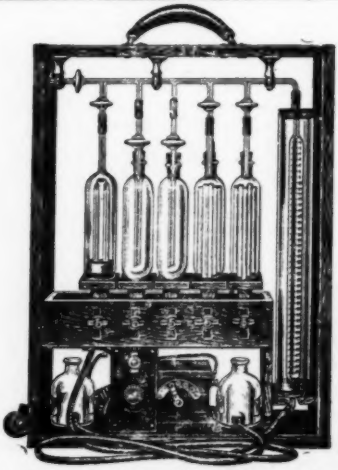
Catalogue on Request

Manufactured by:

Keroy (Private) *Ltd.*

BANARAS CANTT. :: CALCUTTA 10

"Calcutta Telephone No. is 24-3840"



Associated Scientific Corporation

Manufacturers and Dealers in

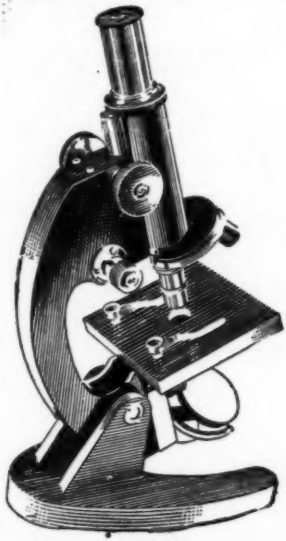
SCIENTIFIC GLASS APPARATUS AND EQUIPMENTS

232 B, UPPER CIRCULAR ROAD

CALCUTTA-4

GRAM : ASCINCORP PHONE { FACTORY : 55-1588 / RESIDENCE : 55-2001

DEDICATED TO INDIA'S SCIENTIFIC PROGRESS



* BIOLOGICAL MICROSCOPES
* DISSECTING MICROSCOPES
* TRAVELLING MICROSCOPES
* SPECTROMETERS
* LABORATORY TELESCOPES
* LENSES & PRISMS

卐

Manufactured by:

INSTRUMENT RESEARCH LABORATORY LTD.

309, Bowbazar Street, CALCUTTA-12

GRAM: "INRELABTRY" PHONE: 22-3060

VERY RELIABLE INDIGENOUS SUBSTITUTES OF GUARANTEED ANALYTICAL REAGENTS MAY BE FOUND IN

"BASYNTH"

Brand

ANALYTICAL REAGENT

Acid Hydrochloric
Acid Hydrochloric Fuming
Acid Sulphuric
Acid Nitric
Acid Nitric Fuming
Acid Acetic Glacial
Ammonium Hydroxide
Benzene
Toluene
Xylene
Petroleum Ether
Amyl Alcohol
Butyl Alcohol Etc., Etc.

ic & Synthetic Chemicals (Private) Ltd.

P.O. Jadavpur University, Calcutta-32

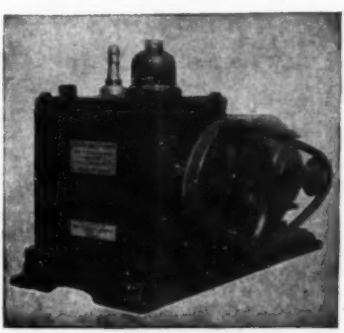
MADE IN INDIA

HIGH VACUUM

ROTARY PUMP

SINGLE STAGE & TWO STAGE
with or without Air Ballast

All Indian materials and construction

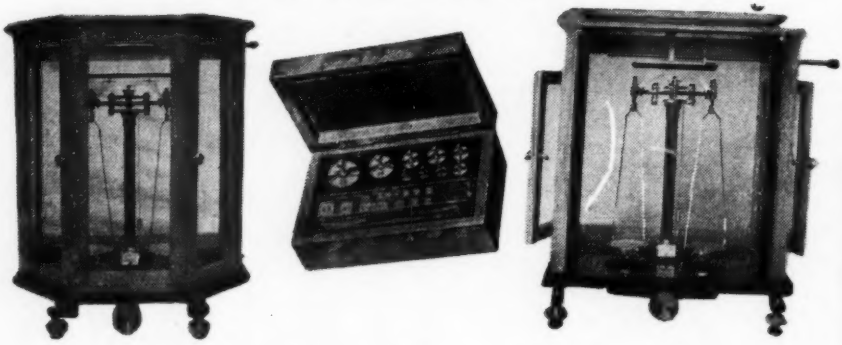


BASIC & SYNTHETIC CHEMICALS (PRIVATE) LTD.

P.O. Jadavpur University, CALCUTTA 32

Balances for . . . . . .

SCHOOLS, COLLEGES, INDUSTRIAL LABORATORIES, RESEARCH INSTITUTES



Catalogues sent on request

Manufactured by :

SCIENTIA INDUSTRIES (India) PRIVATE LTD.

34, Banerji Bagan Lane, SALKIA (Howrah)

Gram : " Presglako " Phone : 55-3583

PREMIER SCIENTIFIC GLASS CO.

26/2 A, PROSOUNA KUMAR TAGORE STREET

CALCUTTA-6

Stockists for

E. MERCK, B.D.H.

CHEMICALS, STAINS, INDICATORS, ACIDS, Etc.

PYREX, JENA, SIGCOL.

LABORATORY GLASS, APPARATUS, PORCELAIN & SILICAWARES, METALLIC INSTRUMENTS.

FILTER & INDICATOR PAPERS.

MICROSCOPES & SLIDES.

BALANCES & WEIGHTS, Etc.

PHOTOSTAT SERVICE

Indian Institute of Science Library can supply PHOTOCOPIES of Articles, Graphs, Charts, Illustrations, Blue Prints, etc., from the Scientific and Technical Publications available in the Library, to Scientists and Scientific Institutions.

Enlarged or Reduced Copies can also be supplied wherever possible

Size upto	Rates per page, per copy
11" × 6"	Re 0·50
17" × 11"	Re. 0·75
23" × 17"	Rs. 1·25

(Packing and postage extra)

For further particulars contact :

LIBRARIAN

INDIAN INSTITUTE OF SCIENCE

BANGALORE 12, INDIA.

Gallenkamp COLORIMETER
(ABSORPTIOMETER)

A NEW ADVANCE IN RAPID READING

REFERENCES

King, E. J., Wootton, I. D. P., Micro-Analysis in Medical Biochemistry 3rd Edn., 1958

Delory, G. E., Photoelectric Methods in Clinical Biochemistry

This colorimeter takes advantage of the latest remarkable improvement in moving coil meters. The new 'Centre Pole' principle has yielded an instrument of all the virtues; extreme robustness and rigidity, accuracy, high sensitivity and brisk stick-free action which gives precise readings in 3 seconds. The 5 in. scale is calibrated directly in extinction (E)

APPLICATIONS

Clinical Tests and Biochemistry. Blood, Urine, Body Fluids, etc.

Food Chemistry. Analysis, and Quality Control.

Analytical Chemistry. Inorganic and Organic Analysis.

Agricultural Chemistry. Soil Analysis.

Metallurgy. Iron, Steel and Non-Ferrous Metal Analysis.

* *fast action - precise reading in 3 seconds.*
* *directly calibrated in extinction (E).*
* *one knob operation.*
* *tropicalised*
* *stabilised light source.*

ASK FOR PUBLICATION 603

Gallenkamp

SUPPLY THE WORLD'S LABORATORIES

Accredited Agents in India

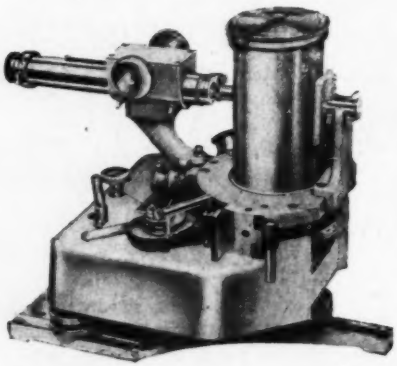
MARTIN & HARRIS (PRIVATE) LTD.
(SCIENTIFIC DEPARTMENT)
SAVOY CHAMBERS, WALLACE STREET, BOMBAY 1, INDIA

UNICAM INSTRUMENTS

—FOR—

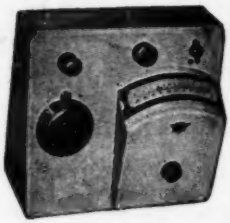
CRYSTALLOGRAPHY, SPECTROPHOTOMETRY & COLORIMETRY

incorporate every advance in technique and every lesson of experience



Model S 25, Single Crystal Goniometer, designed to carry out work on crystal structure by means of rotation or oscillation photographs

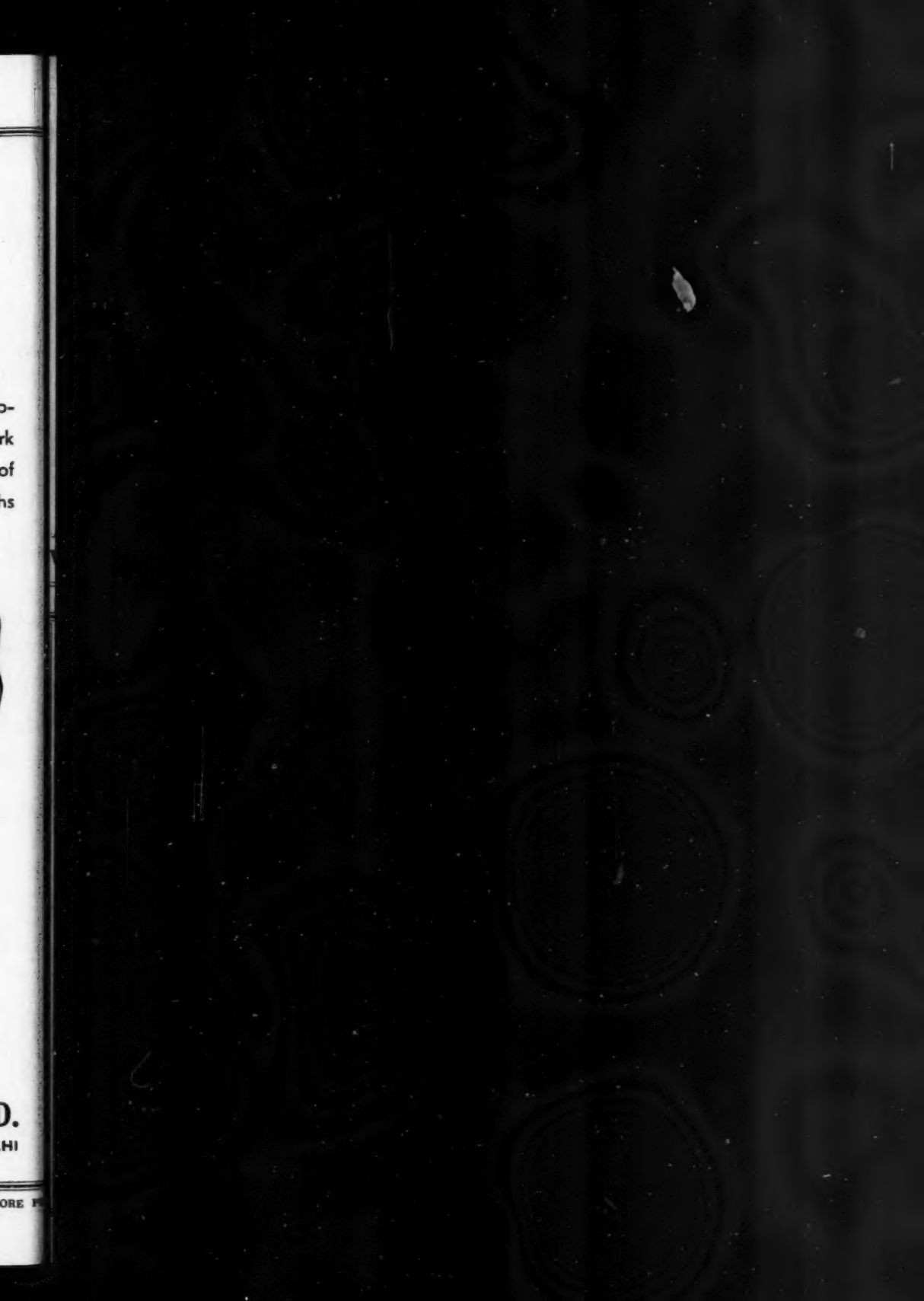
Model SP 350, D.G. Spectrophotometer, for rapidly and accurately determining colorimetric estimations within the visible range of the spectrum. Models are also available covering near infra-red and ultraviolet regions



Model SP 300, G.P. Photoelectric Colorimeter designed to work either from a 6 volt battery or direct from a 200-250 volt A.C. mains through a constant voltage transformer incorporated in the instrument

Illustrated folder on request

Sole Distributors

THE SCIENTIFIC INSTRUMENT COMPANY LTD.

ALLAHABAD BOMBAY CALCUTTA MADRAS NEW DELHI